VOL. 5 NO. 16
August 31, 1980

Energy Research Abstracts

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Technical Information Center
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

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Fusion Energy Update

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ENERGY RESEARCH ABSTRACTS

Charles W. Duncan, Jr.
Secretary

Ruth M. Davis
Assistant Secretary
Resource Applications

Joseph G. Coyne
Manager
Technical Information Center

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Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers, and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

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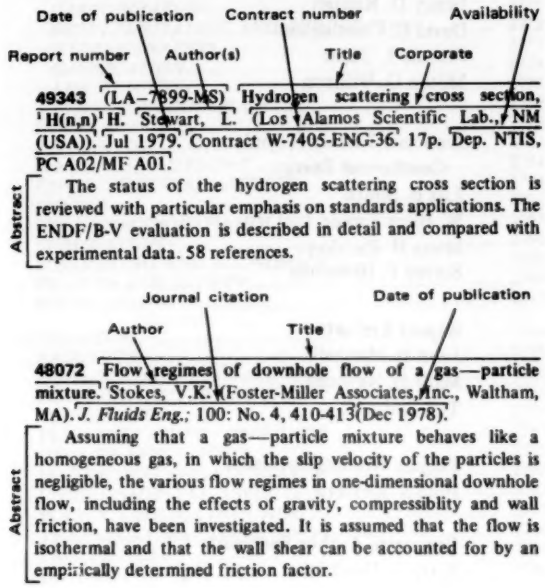
Date of publication
Contract number
Availability
Report number
Author(s)
Title
Corporate
49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.
Journal citation
Date of publication
Author
Title
48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

•INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. These indexes are cumulated semiannually and annually. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

•Corporate Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)

•Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

•Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, $^1H(n,n)^1H$ (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

•Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

LA-7899-MS	4:49343	Dep. NTIS, PC A02/MF A01
LA-tr-78-69	4:48158	Dep. NTIS, PC A03/MF A01

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 25953

25118 (DOE/FE—0006) **Fossil energy program. Summary document.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Fossil Energy). May 1980. 507p. NTIS, PC A22/MF A01.

This program summary document presents a comprehensive overview of the research, development, and demonstration (RD and D) activities that will be performed in FY 1981 by the Assistant Secretary for Fossil Energy (ASFE), US Department of Energy (DOE). The ASFE technology programs for the fossil resources of coal, petroleum (including oil shale) and gas have been established with the goal of making substantive contributions to the nation's future supply and efficienty use of energy. On April 29, 1977, the Administration submitted to Congress the National Energy Plan (NEP) and accompanying legislative proposals designed to establish a coherent energy policy structure for the United States. Congress passed the National Energy Act (NEA) on October 15, 1978, which allows implementation of the vital parts of the NEP. The NEP was supplemented by additional energy policy statements culminating in the President's address on July 15, 1979, presenting a program to further reduce dependence on imported petroleum. The passage of the NEA-related energy programs represent specific steps by the Administration and Congress to reorganize, redirect, and clarify the role of the Federal Government in the formulation and execution of national energy policy and programs. The energy technology RD and D prog4rams carried out by ASFE are an important part of the Federal Government's effort to provide the combination and amounts of energy resources needed to ensure national security and continued economic growth.

25119 (ORNL—5630) **Fossil energy program. Quarterly progress report for the period ending December 31, 1979.** (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 336p. NTIS, PC A15/MF A01.

This quarterly report covers the progress made during the period September 30 through December 31 for the Oak Ridge National Laboratory research and development projects that are carried out in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. These projects are supported by the DOE Divisions of Fossil Fuel Processing, Fossil Fuel Utilization, Fossil Fuel Extraction, Planning and Systems Engineering, Basic Energy Sciences, Office of Health and Environmental Research, Office of Environmental Compliance and Overview, and by the Tennessee Valley Authority and the EPA Office of Research and Development through interagency agreements with the DOE.

25120 (ORNL/TM—7251) **Fossil energy program progress report for January 1980.** (Oak Ridge National Lab., TN (USA)). Mar 1980. Contract W-7405-ENG-26. 105p. NTIS, PC A06/MF A01.

This report - the sixty-sixth of a series - is a compendium of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported this month include those for coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluid bed combustor for cogeneration, process analysis and engineering evaluation, environmental assessment studies, coal preparation and waste utilization, technical support to the TVA fluid bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects.

25121 (ORNL/TM—7285) **Fossil energy program progress report for February 1980.** (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 86p. NTIS, PC A05/MF A01.

This report - the sixty-seventh of a series - is a compendium of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported this month include those for coal conversion development, chemical research and development, materials technology, component and process evaluation studies, technical support to major liquefaction projects, process analysis and engineering evaluations, fossil energy environmental analysis, coal preparation and waste utilization, coal preparation plant automation, atmospheric fluidized bed coal combustor for cogeneration, technical support to the TVA fluidized bed combustion demonstration plant program, and coal cogeneration/district heating plant assessment.

25122 (ORNL/TM—7346) **Fossil Fuels Research Matrix Program. US Environmental Protection Agency/Department of Energy Fossil Fuels Research Materials Facility.** Griest, W.H.; Guerin, M.R. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 52p. NTIS, PC A04/MF A01.

The Fossil Fuels Research Materials Facility was established by an Interagency Agreement between the US EPA and US DOE to provide support for health and environmental-effects studies of alternate fossil fuels technologies. The Facility provides a common source of a wide range of samples which can be drawn upon for methods development and evaluation, interlaboratory comparison, or determination of chemical and physical parameters influencing biological effects. A smaller number of Comparative Research Materials (CRMs) derived from coal, oil shale, and petroleum are available in larger quantities for long-term or detailed comparative generic studies. Samples are made available following approval of the sample suppliers in exchange for reprints or other reports of the investigator's research. Sets of samples differing in some systematic manner (e.g., coal-, shale-, and petroleum-derived counterparts; processing history; etc.) are brought to the attention of investigators expert in various biological and chemical test systems. Samples and the results of the investigations are shared with other participants and with the technology groups supplying the samples. The result is a series of matrix experiments whereby various groups apply a variety of tests to given sets of samples. The matrix program provides a convenient source of useful samples and guidance on sample characteristics and data gaps in exchange for results of the individual investigations.

25123 (JPRS—75533(EXC)) **China report: economic affairs, No. 56.** 21 Apr 1980. Translation of various articles. 9p. NTIS.

Excerpts from two articles are presented: power generation facilities renovated and china must place main emphasis on coal among energy sources.

PROCESSING

REFER ALSO TO CITATION(S) 25234

CARBONIZATION

REFER ALSO TO CITATION(S) 25181, 25198, 25217

25124 (BCRA—66) **Influence of low-volatile coal additions on the strength and structural properties of 7-kg cokes.** (British Carbonization Research Association, Chesterfield). May 1979. 11p. NTIS (US Sales Only), PC A02/MF A01.

Based on the results of carbonizations in the 7-kg oven and laboratory examination of the cokes, the amount of low-volatile additive necessary to produce a coke of maximum strength varied from 40 percent (with a coal of 16 percent volatile matter) to 15 or 20 percent (with coals of 6 to 12 percent volatile matter). The coals of lower volatile matter increased the coke tensile strength by thickening the cell walls; a maximum increase of about 20 percent in cell wall thickness was noted. Changes in the average diameter of the coke pores were noted, but were relatively small. The total porosity of the cokes was reduced by amounts varying from 1 to 8 percent; the largest changes were found with the additive coals of volatile matter 9 to 12 percent. Increases in coke strength and resistance to abrasion due to the inclusion of low-volatile coals in the blends were also observed after testing the cokes in small-scale drum tests. The cokes were generally unreactive, but no systematic effects on reactivity in relation to the properties of the additive coals could be recognized. In some cases there were slight increases and in others slight decreases in the reactivity of the cokes made from coal blends compared with the reactivity of the base coke. The maximum tensile strength of the cokes was equal to that of industrial cokes used in large blast-furnaces.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 25186, 25187, 25195, 25197, 25198, 25221, 26034

25125 (BNL—51106) **Regenerative process for desulfurization of high temperature combustion and fuel gases. Progress report No. 13, April 1-September 30, 1979.** Shen, M.S.; Albanese, A.S. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 25p. NTIS, PC A02/MF A01.

Various types of portland cement were subjected to sulfation/regeneration cycling for application in fluidized bed combustion (FBC) systems. Among them, Type III was the most reactive sorbent for SO_2 absorption. Sulfated portland cement is highly superior in its resistance to attrition than sulfated limestone which has serious attrition loss problems in fluidized-bed combustors. An isothermal sulfation/regeneration cycle for portland cement Type III pellets has been evaluated. Sulfation reactivity was optimized as a function of the quantity of carbon and water used in preparing the pelletz. The sulfation rate was independent of the type of carbon used. Cement kiln dust, a waste product, was also teated as an absorbent for SO_2. TGA experiments on the extent of regeneration and SO_2 concentration in the off-gas under various pressures and temperatures are being conducted. This information is of importance to pressurized fluidized bed (PFC) operations. Cycling of Type III portland cement pellets between sulfation and regeneration conditions indicate good maintenance of capacity with little deterioration after 20 cycles. These cycling experiments are continuing. Experiments are being made with a 3" rotary kiln to provide information on kiln performance under various operating conditions. Among the variables considered are temperature, residence time, extent of regeneration and SO_2 concentration in the off gas. The feasibility of an alternative regeneration scheme has been studied.

25126 (DOE/ET/13399—1) **Development of a solid absorption process for removal of sulfur from fuel gas. First quarterly technical report.** Stegen, G.E.; Olson, K.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC01-79ET13399. 24p. NTIS, PC A02/MF A01.

Battelle Pacific Northwest Laboratories has begun to develop a project for removing sulfur compounds from fuel gases at elevated temperature (> 700°C) based on the use of molten mixtures of alkali metal carbonates and calcium carbonate as the active reactants. The sulfur removal capacity of the molten salt mixture may be regenerated by stripping with CO_2 and steam, usually at a reduced temperature. In this process, the molten salt mixture is contained within the pores of a porous ceramic substrate material which may be used in a packed bed, moving bed, or fluidized bed absorber. The process would be used most advantageously in applications where it is desirable to reduce or eliminate any cooling of the fuel gas between the gasifier outlet and the gas user. Examples of such applications include gas turbines, high temperature fuel cells, boilers, and furnaces which operate in relatively close proximity to a coal gasifier. In these applications, reduction or elimination of the gas cooling requirements will generally improve thermal efficiency by retaining the sensible heat in the gas and may result in simplification of the process by elimination of gas cooling (and in some cases reheating) equipment and by elimination of process condensates and the equipment required for their handling and treatment. The objectives of the program are to obtain process and materials data sufficient to demonstrate feasibility of the process at bench scale and to allow preliminary economic analysis. Process data to be obtained include sorbent sulfur capacity, reaction kinetics, and other operating characteristics. Various candidate materials will be purchased or fabricated and tested for suitability as porous ceramic substrate materials.

25127 (DOE/ET/13399—2) **Development of a solid absorption process for removal of sulfur from fuel gas. Second quarterly technical report.** Stegen, G.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC01-79ET13399. 24p. NTIS, PC A02/MF A01.

Progress on development of the Solid Supported Molten Salt (SSMS) Process is reported. Absorption and regeneration reaction rate data were obtained using a gravimetric technique. Durability and salt impregnation tests were also performed on a number of commercially available and custom fabricated ceramic samples. Results to date indicate that lithium aluminate, magnesium oxide, and zirconium oxide may all be suitable ceramic support materials. Gravimetric reaction rate data has been developed which gives an estimate of reaction rates expected with the solid supported molten salt sorbent. Soaking the ceramic in a bath of the molten salt has been shown to be effective in filling the pores with salt. With some materials it is necessary to draw a vacuum on the bath during soaking in order to remove trapped gases.

25128 (DOE/METC/8085—6) **Coal derived fuel gases for molten carbonate fuel cells.** (TRW Energy Systems Planning Div., Morgantown, WV (USA)). Nov 1979. Contract EY-77-C-21-8085. 91p. NTIS, PC A05/MF A01.

Product streams from state-of-the-art and future coal gasification systems are characterized to guide fuel cell program planners and researchers in establishing performance goals and developing materials for molten carbonate fuel cells that will be compatible with gasifier product gases. Results are presented on: (1) the range of gasifier raw-gas compositions available from the major classes of coal gasifiers; (2) the degree of gas clean-up achievable with state-of-the-art and future gas clean-up systems; and (3) the energy penalties associated with gas clean-up. The study encompasses fixed-bed, fluid-bed, entrained-bed, and molten salt gasifiers operating with Eastern bituminous and Western subbituminous coals. Gasifiers operating with air and oxygen blowing are evaluated, and the coal gasification product streams are characterized with respect to: (1) major gas stream constituents, e.g., CO, H_2, CO_2, CH_4, N_2, H_2O; (2) major gas stream contaminants, e.g., H_2S, COS, particulates, tars, etc.; and (3) trace element contaminants, e.g., Na, K, V, Cl, Hg, etc.

25129 (EPRI-AP—1399) **Economic screening evaluation of upgrading SRC to low sulfur solid boiler fuels.** Angevine, P.J.; Dabkowski, M.J.; Perrella, A.V.; Shih, S.S. (Mobil Research and Development Corp., Paulsboro, NJ (USA). Process Research and Technical Service Div.). May 1980. 46p. NTIS, PC A03/MF A01.

This work was a preliminary scoping study intended to provide a set of internally consistent estimates on the cost of lowering the sulfur content of SRC to different levels. The absolute value of the cost numbers was not expected to be very precise. However, it was considered important to develop some feeling for the relative cost differential between solid SRC products having different sulfur levels. The sensitivity of the cost to the use of different sets of processing conditions was also investigated. These studies, based upon a 20,000 barrel per day processing facility, indicate that the cost of lowering the sulfur content of solid SRC to 0.4 wt% or 0.6 wt% is between $0.50 and $1.00 per 10^6 Btu in an incremental catalytic hydrotreating operation supplied with over-the-fence hydrogen. Separating the products from such an operation into three product streams (a distillate product boiling below 650°F, a second distillate product boiling between 650°F and 900°F, and the solid residual SRC product) adds about $0.25 per 10^6 Btu to this cost. Operation at the higher of the two temperature levels studied appears slightly more desirable economically. However, the projected convesion of a substantial part of the SRC feed to lower boiling liquids, and the likelihood of a significantly higher catalyst deactivation rate obtained at those conditions, would obviate its advantage. Attempting to produce 0.2 wt% sulfur content solid product is projected to cost about $0.50 per 10^6 Btu more and reduce the yield of solid SRC product.

25130 (FE—1517-93) **Coal liquefaction and deashing studies of the CSF and SRC processes. Special report, December 1975-October 1977.** Kleinpeter, J.A.; Jones, D.C.; Dudt, P.J.; Burke, F.P.; Rutledge, G.D.; Rice, C.H. (Conoco Coal Development Co., Library, PA (USA)). Jan 1980. Contract EX-76-C-01-1517. 297p. NTIS, PC A13/MF A01.

Continuous bench-scale studies on the deashing of coal liquefaction products by gravity settling were conducted in a 10 lb coal/hour unit. Steady-state liquefaction solvents were used to give as good a simulation as possible. The SRC data were used in a conceptual design for the solvent deashing unit of a commercial coal liquefaction plant. Anti-solvent (deasphalting or precipitating solvent) screening was done in a batch system before continuous runs using anti-solvent were made. Deashed CSF product contained 0.22 wt % ash; using anti-solvent did not improve settling efficiency. The upflow velocity of the settler was 0.3 in/min, which is about 25% of the value obtained in a previous study using non-steady-state liquefaction solvent. Mass spectral and NMR analyses of liquefaction solvent used in the CSF program indicate that essentially steady-

state operation was reached in the third cycle of the four cycle program. SRC with 0.1 wt % ash was produced using an anti-solvent/liquefaction solvent weight ratio of 0.3 to 0.5. The recovery of SRC was 85% in this single-stage operation. The upflow velocity was 0.4 in/min. Deashing was sensitivie to the amount of Soltrol 130 (a paraffinic naphtha) used as anti-solvent. Equilibrium liquefaction solvent from the Ft. Lewis SRC pilot plant was used. A conceptual design of a two-stage solvent deashing unit for a commercial (20,000 TPSD) SRC plant shows that thirty-five 40' diameter primary settlers (600°F, 77 psig) and twenty wash settlers (550°F, 54 psig) of the same diameter are required to produce specification SRC (0.18% ash). The SRC recovery in the two-stage system is estimated at 97% of the entering SRC.

25131 (FE—2728-6) **Electrochemical disposal of H_2S. Final report, August 31, 1977-August 30, 1979.** Angus, J.C.; Brosilow, C.B.; Gregory, T.D.; Landau, U. (Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Chemical Engineering). Jan 1980. Contract EF-77-G-01-2728. 94p. NTIS, PC A05/MF A01.

Hydrogen sulfide disposal via direct electrolysis of its liquid phase has been investigated. This process is potentially superior to the Claus process in that it produces both hydrogen and sulfur, and it is hoped that the value of products will more than offset the additional electricity costs. Among substances used as supporting electrolytes, pyridine produced the highest solution conductivity; the addition of liquid CO_2 caused a significant decrease in conductivity. A mechanism for the action of pyridine as the electrolyte involving the formation of pyridinium and HS^- ions has been proposed. Experiments indicate that the current density may be limited by diffusion of HS^- ions to the anode. Hydrogen was produced at the cathode at a current efficiency of 99.5 +- 0.3%. The major anodic product was sulfur, with an anodic current efficiency of 89.1 +- 0.5%. Ohmic losses in the solution accounted for most of the cell voltage drop, and surface overpotentials were the next largest source. Graphite proved to be the most satisfactory electrode material tried. A preliminary optimization and economic analysis showed that solution conductivity must be increased further and electrodes with lower overpotentials must be found if H_2S electrolysis is to become an important commercial process. Using experimental data on solution conductivities and surface overpotentials, an H_2S electrolysis plant for processing the acid gas from a 250 x 10^6 SCFD coal gasification plant would produce hydrogen and sulfur worth about $7.4 million per year at current market prices, and incur yearly electricity costs of about $15.6 million. Assuming a solution conductivity 500 times the highest yet produced in the laboratory, electricity costs would drop to about $4.2 million annually.

25132 (FE—3044-T7) **Cryogenic methane separation/catalytic hydrogasification process analysis. First quarter report, October 15, 1978-January 15, 1979.** (Air Products and Chemicals, Inc., Allentown, PA (USA)). 16 Jan 1979. Contract ET-78-C-01-3044. 19p. NTIS, PC A02/MF A01.

Efforts have been directed towards identifying the most attractive acid gas removal systems, per case, based on preliminary screenings. Using proprietary information obtained from the respective vendors of the Benfield and Rectisol acid gas removal processes, preliminary cost estimates have been completed for the Exxon CCG process. Several sets of computer simulations, for different acid gas removal configurations, for the Selexol process have been developed to optimize methane recovery and utility savings. As dictated by the flow of information, the evaluation of acid gas removal processes for the Rockwell SNG process is four to six weeks behind the acid gas removal studies for the Exxon process. For the Rockwell case, Sulfinol, DEA and DGA, acid gas removal processes are being evaluated.

25133 (FE—3245-9) **Simultaneous high-temperature removal of alkali and particulates in a pressurized gasification system. Exploratory research on advanced gasification processes for coal, char or carbonaceous residues. Annual technical progress report, October 1978-September 1979.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). 1979. Contract ET-78-C-01-3245. 129p. NTIS, PC A07/MF A01.

In the present study, Westinghouse is examining the feasibility of a hot gas cleaning process to minimize the concentration of alkali in a high-temperature fuel gas with simultaneous particulate removal through the use of aluminosilicate materials (getters). There are four program objectives. The gettering capacity will be kinetically defined by thermogravimetric analysis of three selected getters - kaolinite, ash from a low-temperature coal char, and ash from a high-temperature gasifier. Using detailed chemical and physical analyses of the reacted aluminosilicates, the gettering mechanism will be delineated as either a chemical or a sorption process. System performance projections, for a coupled alkali and particulate removal system, will be developed from the fundamental kinetic and thermodynamic data. Finally, the system performance projections will be utilized to define a plan for concept scale-up: preliminary bench scale, ten-atmosphere exposures of the 1/8" x 1/8" cylindrically fabricated kaolin, low carbon ash and char samples in a 0.5 scfm stream of argon containing ~ 80 ppM NaCl have been completed. The candidate getters were exposed at bed temperatures of 850°C and 900°C for a one-hour period. Available results for kaolin showed that a 7.8-fold increase in total sodium content was obtained at 850°C. At 900°C, the gettering capacity diminished to approximately a 4.7-fold increase. Similar results are presently not available for the remaining two candidate getters.

25134 (IS—4739) **Fossil energy quarterly report, January 1-March 31, 1980.** (Ames Lab., IA (USA)). Apr 1980. Contract W-7405-ENG-82. 41p. NTIS, PC A03/MF A01.

This report covers objectives and progress for seven areas of the Ames Laboratory Fossil Energy Program for the period January 1 through March 31, 1980.

25135 Treatment of coal with metal containing compounds. Kindig, J.K.; Turner, R.L. (to Hazen Research, Inc.). US Patent 4,175,924. 27 Nov 1979. Filed date 10 Feb 1977. 12p.

Raw coal is improved by reacting it with a metal containing compound selected from the group consisting of organic iron containing compounds which exert sufficient vapor pressure, with iron as a component in the vapor, so as to bring the iron into contact with the impurity at the reaction temperature, organic iron containing compounds in solution at the injection temperature, solid organic iron containing compounds capable of being directly mixed in solid form at the mixing temperature with the coal, and ferrous chloride, ferric chloride, and alkyl aluminum compounds, in order to enhance the magnetic susceptibility of certain impurities, e.g., pyrite and ash-forming minerals contained in the raw coal, thereby permitting the removal of these impurities by magnetic means.

HYDROGENATION

REFER ALSO TO CITATION(S) 25185

25136 (DOE/ET/1488—1) **Mechanisms and kinetics of coal hydrogenation. Quarterly progress report, October-December 1979.** Gary, J.H.; Baldwin, R.M.; Bain, R.L. (Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering). Feb 1980. Contract AC01-79ET14881. 17p. NTIS, PC A02/MF A01.

Colorado School of Mines is conducting coal hydrogenation research with the following objectives and scope of work: (1) Comparison of the rates of coal hydrogenation in continuous flow stirred tank and tube flow reactors using pure hydrogen, catalyzed CO-STEAM, and syngas processing conditions; (2) Investigation of the influence of coal rank on the rate of hydrogenation of coal to preasphaltene, asphaltenes, and oil in batch reactors; (3) Batch evaluation of the effect of operating conditions (temperature and pressure) on the rate of hydrogenation of coal-derived preasphaltanes and asphaltenes; (4) Determination of the effect of selected disposable catalysts on the rate of batch hydrogenation of preasphaltenes and asphaltenes and selected bituminous coals. Testing and evaluation of promising catalyst systems in the contunuous processing unit; (5) Formulation of a unified kinetic/mechanistic model for coal liquefaction taking into account petrography of the feed coal and hydrocarbon lumps in the product oil.

25137 (DOE/ET/13153—T1) **Short residence time hydropyrolysis of coal. Technical progress report, 1 October 1979-31 December 1979.** Saville, D.A.; Russel, W.B. (Princeton Univ., NJ (USA). Dept. of Chemical Engineering). 1979. Contract AC01-79ET13153. 21p. (PU—3153-1). NTIS, PC A02/MF A01.

A fundamental study of the hydropyrolysis of small coal particles at high pressures and short residence times of both solid and gas is underway to elucidate the chemical and physical rate processes governing the yield and product distributions. Our experimental system has been designed to rapidly heat and quench small samples of coal in batch. Heating rates to 10^4 degree C/s and temperatures to 1000°C are feasible, and quench times of the order of 50 ms have been achieved. Throughout the temperature program all volatile products are swept continuously from the coal particles by a stream of flowing gases and coled abruptly at a fixed point downstream of the reactor. The flowing stream will range from pure helium to pure hydrogen at pressures up to 100 atm and temperatures to 1000°C. After cooling, products are swept through a set of traps which will fractionate them for subsequent elemental and chromatographic analyses. In addition the small particles can be observed during reaction through a viewing port equipped with a microscope and high-speed movie camera or video recorder. Our objectives are (1) to control the environmental conditions as closely as possible to isolate competing rate processes and (2) to resolve the physical transformations and product evolution on time scales on the order of 100 ms, and thereby obtain time-resolved kinetic data to identify the major stages of this complex reaction system.

GASIFICATION

REFER ALSO TO CITATION(S) 25128, 25133, 25198, 25201, 25212, 25231, 25232, 25283, 25587, 26086, 26101, 26236

25138 (CONF-800371—1) **Rheology and transportation characteristics of a coal gasification feed slurry.** Onischak, M.; Gupta, K.K.; Babu, S.P.; Pouska, G.A. (Institute of Gas Technology, Chicago, IL (USA); Colorado School of Mines, Golden (USA). Research Inst.). 1980. Contract ET-78-C-01-2806. 02p. NTIS, PC A02/MF A01.

From 5. international technical conference of slurry transportation; Lake Tahoe, NV, USA (26 Mar 1980).

Coal-light oil slurry technology for high-pressure reactor feed has been in use at the HYGAS pilot plant. This paper investigates the slurry-pumping characteristics for the alternative water-based feed system with Eastern coals. The water-based slurry transport system could originate at the mine and involve wet crushing, wet sizing, submerged particle oxidation of coal to reduce the agglomerating property of Eastern coals, and mechanical dewatering operations before feeding to the high-pressure reactor. Rheological and pumping characteristics of an Illinois No. 6 run-of-mine coal are examined for a typical gasifier feed-size consist of -14 mesh, with 10% less than 100 mesh as a water and toluene slurry. The information developed here is useful for design considerations of a gasification slurry-fed reactor, especially for the low-pressure, wet-handling, feed preparation portion. The vertical lift and pressurization to high pressures would be controlled more by the high pressure pump design rather than slurry characteristics. However, slurry characteristics are very important in the upstream feed-preparation steps. For a continuous flow operation, these steps involve mixing various-sized feeds and concentrations from various crushers and screens. Understanding the limits of pumping, aids in designing an efficient operation and managing feed delivery, water requirements, and system wear.

25139 (COO—2904-16) **Chemical and physical stability of refractories for use in coal gasification. Sixteenth quarterly progress report, February 1, 1980-April 30, 1980.** Fakhr, A.; Lewis, G.L.; Day, D.E. (Missouri Univ., Rolla (USA)). 30 Apr 1980. Contract AS02-76ET10544. 27p. NTIS, PC A03/MF A01.

Experiments on the corrosion resistance and thermal expansion of refractories for coal gasification plants are reported. The properties of a given castable were basically similar after exposure, regardless of whether the specimens had been immersed in liquid or in contact with saturated vapor. The thermal expansion of several refractories over the temperature range of 20°C to 950°C, and exposed to the DOE atmosphere of containing 1 vol % H_2S at 1000 psi, is reported. Some samples were cycled from 465°C to 1000°C. (LTN)

25140 (DOE/ET/03117—T1) **DOE Coal Gasification Multi-Test Facility: fossil fuel processing technical/professional services.** Hefferan, J.K.; Lee, G.Y.; Boesch, L.P.; James, R.B.; Rode, R.R.; Walters, A.B. (UOP, Inc., Des Plaines, IL (USA); System Development Corp., McLean, VA (USA)). 13 Jul 1979. Contract ET-78-C-01-3117. 716p. (TR—79/013A-01). NTIS, PC A99/MF A01.

A conceptual design, including process descriptions, heat and material balances, process flow diagrams, utility requirements, schedule, capital and operating cost estimate, and alternative design considerations, is presented for the DOE Coal Gasification Multi-Test Facility (GMTF). The GMTF, an engineering scale facility, is to provide a complete plant into which different types of gasifiers and conversion/synthesis equipment can be readily integrated for testing in an operational environment at relatively low cost. The design allows for operation of several gasifiers simultaneously at a total coal throughput of 2500 tons/day; individual gasifiers operate at up to 1200 tons/day and 600 psig using air or oxygen. Ten different test gasifiers can be in place at the facility, but only three can be operated at one time. The GMTF can produce a spectrum of saleable products, including low Btu, synthesis and pipeline gases, hydrogen (for fuel cells or hydrogasification), methanol, gasoline. diesel and fuel oils, organic chemicals, and electrical power (potentially). In 1979 dollars, the base facility requires a $288 million capital investment for common-use units, $193 million for four gasification units and four synthesis units, and $305 million for six years of operation. Critical reviews of detailed vendor designs are appended for a methanol synthesis unit, three entrained flow gasifiers, a fluidized bed gasifier, and a hydrogasifier/slag-bath gasifier.

25141 (DOE/ET/10254—78) **Test and evaluate the TRI-GAS Low-Btu Coal Gasification Process. Quarterly report, January-March 1980.** (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Apr 1980. Contract AC21-80ET10254. 19p. NTIS, PC A02/MF A01.

New silicon carbide liners were cast for all three reactor vessels. The new liners will facilitate installation of the new reactor heaters and make possible a better seal between the heaters and vessel internals. Globar heating elements were received, cut to length, and installed on the new silicon carbide vessel liners in Stages 2 and 3. The heater for Stage 1 was reassembled on the new silicon carbide liner and installed in the vessel. Preliminary tests were made following the installation of the silicon carbide liners and heaters. The Stage 2 heater failed open, due to poor contact, after a few hours of testing. This problem was solved by nickel plating the ends of the Globars and using graphite packing to cushion the connector set screws.

25142 (DOE/ET/14809—T1) **Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. Quarterly technical progress report, December 19, 1979-March 18, 1980.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 10 Apr 1980. Contract AC01-79ET14809. 40p. NTIS, PC A03/MF A01.

A 15% Fe/SiO_2 catalyst was prepared. H_2 and CO chemisorption uptakes were measured for the catalysts prepared to date. Very small uptakes were noted for the silica supported iron catalysts. Reactor activity tests in synthesis gas were conducted for 3% Fe/SiO_2, 15% Fe/SiO_2 and 10% Co-B/Al_2O_3 catalysts. These preliminary tests aided the final development of a laboratory microreactor system. Criteria for avoiding heat and mass transfer limitations on intrinsic rate measurements were examined and applied to the catalyst activity tests.

25143 (DOE/MC/08484—T1) **Pittsburgh Energy Technology Center hydrogasification process: conceptual commercial scale plant design.** (Dravo Corp., Pittsburgh, PA (USA). Chemical Plants Div.). 28 Dec 1979. Contract AC21-78MC08484. 115p. NTIS, PC A06/MF A01.

The Dravo Corporation has conducted a study for the Morgantown Energy Technology Center, US Department of Energy to generate conceptual commercial scale SNG plant designs based on hydrogasification pilot plant work performed at the Pittsburgh Energy Technology Center. PETC hydrogasification pilot plant tests at various H_2:coal ratios and coal throughputs or North Dakota lignite, Illinois No. 6 and a Western sub-bituminous coal were reviewed. Additional testing at higher H_2:coal ratios confirmed that greater coal throughputs were possible. Conceptual commercial scale plant designs based on the North Dakota lignite and the Illinois No. 6 coal should total plant investment figures of $1668 MM and $1998 MM for the two coals, respectively. Gas costs based on the Utility Finance Method of calculation yielded costs ranging from $4.91/MM Btu and $5.26/MM Btu for lignite at $5.00 and $8.00 per ton. Corresponding figures for the Illinois No. 6 coal were gas costs of $6.08 to $6.73 for coal costs of $20 and $30 per ton, respectively. Gas cost sensitivity analyses are performed. Further study of the process is warranted based on the favorable overall thermal efficiencies for both coals (70% +), favorable gas costs and the technology compatible with present state of the art materials and equipment.

25144 (DOE/MC/12420—T1) **Closed Loop Test Facility for hot dirty gas valves.** (Wyle Labs., Norco, CA (USA)). 6 Feb 1980. Contract AC21-79MC12420. 106p. NTIS, PC A06/MF A01.

A design study of a closed loop test facility for eight-inch hot dirty gas valves is presented. The objective of the facility is to quality valves for use in coal gasifiers, combined cycle plants, and pressurized fluid bed combustors. Outline sketches and estimated costs are presented for the selected design.

25145 (DOE/TIC—11155) **Subject listing: intrabureau reports, and selected information circulars, reports of investigation, outside publications, technical progress reports, and FE/EES reports through fiscal year 1978.** Conley, L.A. (Department of Energy, Morgantown, WV (USA). Process Evaluation Office). Dec 1978. 43p. NTIS, PC A03/MF A01.

25146 (FE—1514-101) **Advanced coal gasification system for electric power generation. Quarterly progress report, January 1-March 31, 1979.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Coal Conversion Dept.). 31 Aug 1979. Contract EF-77-C-01-1514. 68p. NTIS, PC A04/MF A01.

Additional testing of the gasifier-agglomerator reactor included direct coal feed as well as oxygen-blown gasification of a char or coal bed. These tests will be followed by evaluation of the integrated system consisting of the devolatilizer and gasifier-agglomerator. Present work involves the modification and upgrading of the PDU to provide for integration of the two reactors as well as to modify the hardware to achieve better performance as dictated by the results of prior testing efforts. Support work on fuel processing was conducted to investigate operating conditions for the PDU test program, provide troubleshooting capability for PDU operation, obtain data for PDU modifications, analyze and interpret results from PDU opeation, develop process models for scale-up, and understand process phenomena to achieve reliable operation. Work was conducted in the areas of cold flow and analytical modeling, coal behavior, coal and ash chemical phenomena, environmental impact, and process and systems engineering consultation.

25147 (FE—2434-33a) **Pipeline gas from coal: hydrogenation (IGT hydrogasification process). Project 9000 interim report No. 2, July 1, 1977-June 30, 1978.** (Institute of Gas Technology, Chicago, IL (USA)). May 1980. Contract EX-76-C-01-2434. 384p. NTIS, PC A17/MF A01.

Test 64 was conducted to acquire data with Peabody No. 10 Mine bituminous coal at high carbon conversions. Eight and one-half days of self-sustained operation was maintained, with carbon conversions ranging from 72% to 83%. In Test 66 over 9 days of reactor operation were logged. Steady-state, self-sustained operation was achieved at a char feed rate of about 2 tons/h and at char conversions ranging from 62% to 90%. Test 67 was conducted to obtain data at high char conversions with high char throughputs. Over 14 days of self-sustained operation were logged, including 6 hours of operation at a 3 ton/h char feed rate and char conversions of 77%. Illinois No. 6 coal was used for Tests 68 through 70. Forty-five tons of char were fed during Test 68 before a leak forced its early termination. One hundred eighteen tons of char were fed to the reactor during Test 69 before a lack of high-pressure nitrogen forced its end. The reactor operated very well during Test 70 at operating conditions necessary for high char conversions at high throughputs. Two hundred seventy-nine tons of pretreated char were fed at a rate of 3 tons/h for 46 hours. Test 71 was conducted to determine whether the major modifications recently incorporated would facilitate optimum operating conditions and clinker-free operation. The steam-oxygen zone was entirely clinker-free after Test 71. Test 72 was conducted to optimize reactor operation by improving char conversion, increasing the temperature in the steam-oxygen gasifier to 1800°F, and continuing to reduce the steam-to-char ratios. Test 73 was initiated to achieve a lower steam-to-char ratio and a significantly lower superficial gas velocity in the steam-oxygen gasifier.

25148 (FE—2434-41) **Pipeline gas from coal: hydrogenation (IGT Hydrogasification Process). Quarterly report No. 10, October 1-December 31, 1978.** (Institute of Gas Technology, Chicago, IL (USA)). Jan 1980. Contract EX-76-C-01-2434. 137p. NTIS, PC A07/MF A01.

Tests 75 and 76 were completed. Test 77 was still in progress at the end of December. Test 75 marked the return to high-pressure (900-psig) operation following successful low-pressure (500-psig) operation of the HYGAS reactor during Tests 71 through 74. The initial operating conditions for Test 75 were designed to explore different steam distributions between the fluidizing ring and the steam-oxygen distributor. These conditions were achieved before a leak at the Grayloc flange leading to the steam-oxygen gas distributor forced the early termination of the test. Test 76 involved operation at high pressure (900 psig) and commercial/demonstration plant design steam-to-char and oxygen-to-char ratios. Several steady-state periods were selected for detailed study, and preliminary data from these periods are presented. The objective of Test 77 is to test the gasification behavior of Peabody No. 10 Mine caking bituminous, ROM coal at a 500-psig operating pressure, steam feed rates of 500 lb/hr, and 85% char conversion. Initial pretreater operation with ROM coal was sluggish; solids flow from the pretreater to the char cooler was poor. The pretreater was inspected, and the problem was solved by experimentally determining that ROM coal has a higher complete fluidization velocity than the washed coal from the same mine that had been used in previous tests. Increasing the superficial velocity in the char cooler and reducing the operating temperature in the pretreater reactor vessel significantly improved pretreater operation.

25149 (FE—2434-50) **Pipeline gas from coal: hydrogenation (IGT Hydrogasification Process), July 1, 1978-June 30, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). May 1980. Contract EF-77-C-01-2434. 228p. NTIS, PC A11/MF A01.

During this period, Tests 74 through 79 were completed and Test 80 was initiated. In Test 74, twenty-one days of continuous self-sustained operation were logged, breaking all previous records and accumulating over 200 hours of steady-state operation. A leak flange leading to the steam-oxygen gas distributor forced the early termination of test 75. The objective of test 76 was to operate at high pressure (900 psig) and commercial/demonstration plant design steam-to-char and oxygen-to-char ratios. When it became impossible to isolate a pinhole leak that had occurred in the spent-char slurry line, Test 76 was terminated. The objective of Test 77 was to test the gasification behavior of Illinois No. 6 seam, Peabody No. 10 Mine, ROM bituminous coal at a 500-psig operating pressure, steam feed rates of 500 lb/hr, and 85% char conversion. After more than a month of operation Test 77 was terminated when it became apparent that, as a result of a severe winter storm, no trucks would be able to deliver the nitrogen required for high-pressure operation. The reactor operated under self-sustained conditions for 708 hours and 237 tons of coal were fed. A great deal of useful information was obtained. Test 78 was concluded because of a leaking valve at the bottom of the feed slurry mix tank and solids transfer problems between the slurry dryer and the LTR in the gasifier. Significant experience was gained operating the coal-handling and pretreatment sections. Test 79 was highly significant because it was the longest continuous steady-state HYGAS test ever produced with this ROM coal.

25150 (FE—2434-54) **Pipeline gas from coal-hydrogenation (IGT hydrogasification process). Quarterly report No. 13, July 1-September 30, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). Jan 1980. Contract EX-76-C-01-2434. 76p. NTIS, PC A05/MF A01.

Two significant achievements were made in Test 80: first, the conditions required for the first phase of the test were attained, and a 16 1/2 hour steady-state period was logged. During this period, char conversion reached 90% with an oxygen feed rate of 931 lb/hr and an average SOG maximum temperature of 1789°F. Second, although temperatures in the SOG rose above 1800°F for a total of 30 hours, the reactor was completely sinter-free after the test. Test 81 operations and post-run inspection were conducted to investigate the gasification behavior of caking Illinois No. 6, bituminous ROM coal from the Peabody No. 10 Mine. Once again coal preparation and pretreatment were smooth, although the slurry preparation section operated much better than in Test 80. When it became apparent that char could not be discharged from the reactor, the test was ended. The plant was in generally good condition after the test; the slurry-dryer grid, the low- and high-temperature reactors (LTR and HTR), and all solids transfer lines were clear and free of solids. Operations and post-run inspection for Test 82 were conducted to further investigate the gasification behavior of caking Illinois No. 6, bituminous ROM coal from the Peabody No. 10 Mine. The coal preparation and pretreatment sections operated well during this period. The reactor operated in a self-sustained mode for 118 hours, during which 151 tons of ROM char were processed through the gasifier and 30 1/2 hours of steady-state operation were achieved. The test was terminated after a temperature excursion occurred in the SOG zone of the reactor. The post-run inspection confirmed the plant's generally good condition.

25151 (FE—2434-58) **Pipeline gas from coal: hydrogenation (IGT hydrogasification process). Quarterly report No. 14, October 1-December 31, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). May 1980. Contract EX-76-C-01-2434. 75p. NTIS, PC A04/MF A01.

The objective of this project is to perform the pilot plant operations and related support studies necessary to establish a data base to optimize the design of the HYGAS Process. Test 83 operations and post-run inspection were conducted to determine the operating behavior of washed Kentucky coal under process conditions. After smooth, continuous solids transfer could not be established through the 339 line from the high-temperature reactor (HTR) to the steam/oxygen gasifier (SOG), the test was terminated. Several holes and a crack found in solids transfer line 339 during the post-run inspection were the source of these difficulties. Test 84 was the second test of a new series with Western Kentucky coal, and the objectives were the same as those of Test 83. The reactor operated in a self-sustained mode for 215 hours, during which 317 tons of pretreated char were fed to the gasifier. Three steady-state periods, totaling 83.5 hours, were selected for detailed analysis. Routine maintenance and major turnaround work in preparation for Test 85 was started.

25152 (FE—2468-59) **Materials for coal conversion and use. Volume II, Part I and II. Final report on Task 005.** Nangia, V.K. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Oct 1979. Contract EF-77-C-01-2468-005. 409p. Dep. NTIS, PC A18/MF A01.

ESCOE is reviewing the work done to date on behavior of materials in coal conversion and utilitization working environments. The complete report consists of three volumes. Volume I, Materials of Construction for Atmospheric Fluidized Bed Coal Combustion, has been completed and issued. In addition to this second volume, Materials of Construction for Coal Conversion Systems, there is a third volume, Materials of Construction for Advanced Power Systems. Advanced power systems include magnetohydrodynamics power generation, fuel cells, pressurized fluidized bed combustion, and high-temperature turbines. These volumes describe the present and past work on behavior of materials in the environments of coal conversion and use systems; evaluate the available data; identify materials problems; areas; define operating conditions in terms of temperature, pressure, erosive and corrosive environments, and their effects on the construction materials; propose candidate materials of construction based on extrapolation of the available data and related experience from other technologies; and recommend areas needing further research and development. Volume II is presented in two parts: Part I-Coal Gasification, Chapter 1.0 through Chapter 8.0; Part II-Coal Liquefaction, Chapter 9.0 through Chapter 13.0.

25153 (FE—2469-49) **Experimental program for the development of peat gasification. Process designs and cost estimates for the manufacture of 250 billion Btu/day SNG from peat by the PEATGAS Process. Interim report No. 8.** Arora, J.L.; Tsaros, C.L. (Institute of

Gas Technology, Chicago, IL (USA)). Feb 1980. Contract EX-76-C-01-2469. 52p. NTIS, PC A04/MF A01.

This report presents process designs for the manufacture of 250 billion Btu's per day of SNG by the PEATGAS Process from peats. The purpose is to provide a preliminary assessment of the process requirements and economics of converting peat to SNG by the PEATGAS Process and to provide information needed for the Department of Energy (DOE) to plan the scope of future peat gasification studies. In the process design now being presented, peat is dried to 35% moisture before feeding to the PEATGAS reactor. This is the basic difference between the Minnesota peat case discussed in the current report and that presented in the Interim Report No. 5. The current design has overall economic advantages over the previous design. In the PEATGAS Process, peat is gasified at 500 psig in a two-stage reactor consisting of an entrained-flow hydrogasifier followed by a fluidized-bed char gasifier using steam and oxygen. The gasifier operating conditions and performance are necessarily based on the gasification kinetic model developed for the PEATGAS reactor using the laboratory- and PDU-scale data as of March 1978 and April 1979, respectively. On the basis of the available data, this study concludes that, although peat is a low-bulk density and low heating value material requiring large solids handling costs, the conversion of peat to SNG appears competitive with other alternatives being considered for producing SNG because of its very favorable gasification characteristics (high methane formation tendency and high reactivity). As a direct result of the encouraging technical and economic results, DOE is planning to modify the HYGAS facility in order to begin a peat gasification pilot plant project.

25154 (FE—2496-25) **Summary of C-MU's environmental technical support studies at the CO_2-acceptor coal gasification pilot plant.** Fillo, J.P.; Pochan, M.J.; Nakles, D.V. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). Jan 1980. Contract EX-76-S-01-2496. 67p. NTIS, PC A04/MF A01.

Significant degradation of effluent species in aqueous condensate samples can occur if samples are not properly preserved. Specifically, cyanide and thiocyanate required precipitation of soluble sulfide immediately upon sample collection. Significant variability in effluent concentratin with time occurs as a result of variations in process operating parameters. This variability can be partially attributed to fluctuations in coal feed rate. Ultimately, the residual variability will be correlated with process parameters to define the necessary relationships for extrapolation of the pilot plant data base. Results of raw product gas characterization before and after the quench tower indicated: (1) Ammonia production accounted for nearly 100% of the coal feed nitrogen, corresponding well with aqueous condensate characterization. (2) Removal of impurities from raw product gas by the quench tower varies significantly, ranging from ~ 50% for HCN to effectively 100% for ammonia. (3) Limited data indicate sulfur production in the overhead gas of ~ 45% of the feed coal sulfur. Significant evidence was collected regarding the formation/decomposition phenomena governing effluent production: (1) Devolatilization of hydrocarbon species from incoming fresh coal is restricted exclusively to a small region in the vicinity of fresh gasifier coal feed. (2) Characteristics of phenolic compound production from the CO_2-Acceptor gasifier is a combination of formation during coal devolatilization and subsequent decomposition in the gasifier char bed, whereas ammonia and hydrogen cyanide production appear independent of residence time/decomposition effects. (3) Formation of hydrocarbon tars and oil appears to be inhibited during coal devolatilization in the presence of fluidized coal/char.

25155 (FE—2542-24) **Pipeline gas demonstration plant. Phase I. Quarterly technical progress report, 1 July 1979-30 September 1979.** Watson, W.B.; Leaman, G.J. Jr. (comps.). (Conoco, Inc., Stamford, CT (USA)). Oct 1979. Contract EF-77-C-01-2542. 42p. NTIS, PC A03/MF A01.

Contract No. EF-77-C-01-2542 between Conoco Inc. and the US Department of Energy requires Conoco Inc. to design, construct, and operate a demonstration plant for the manufacture of high-Btu gas from bituminous coal. The project is currently in the design phase. The main accomplishments during the reporting period were: the process and engineering designs of the demonstration plant continued and remained on schedule; all of the site-related reports have been completed; plans for obtaining the coal and coke feedstocks for Phase III operation of the demonstration plant were being developed; and all of the baseline environmental data required for the environmental report have been collected, and most of the data has been analyzed.

25156 (FE—2542-25(Vol.3)) **Phase I: the pipeline gas demonstration plant. Environmental report.** (Conoco, Inc., Stamford, CT (USA)). 1979. Contract EF-77-C-01-2542. 295p. NTIS, PC A13/MF A01.

Contract No. EF-77-C-01-2542 between Conoco Inc. and the United States Department of Energy requires Conoco Inc. to design, construct and operate a Demonstration Plant capable of converting eastern US bituminous coals into pipeline quality gas. The main purpose of the project is to demonstrate technology which can produce clean fuels from coal in a safe, reliable, and environmentally acceptable manner. A site consisting of about 1245 acres in Noble County, Ohio, has been tentively selected for the location of the Demonstration Plant. A comprehensive environmental study and an assessment of the effects of the Demonstration Plant on the environment have been undertaken and completed by Energy Impact Associates of Pittsburgh, Pennsylvania. A six volume Environmental Report covering the environmental study and assessment has been prepared: (1) Project Description; (2) Existing Environment; (3) Project Impact and Alternatives; and (4-6) Environmental Data. This is Volume 3. Volume 3 discusses the environmental consequences of the proposed project, alternatives to the proposed project, mitigating measures, and a proposed environmental monitoring program for construction and operation of the Demonstration Plant. No major environmental impacts are expected from plant construction and operations although there would be some impacts on air quality, terrestrial ecology, and aquatic ecology in the plant site area. The proposed environmental monitoring program is expected to provide the requisite data which will permit designing, constructing, and operating a commercial plant in an environmentally acceptable manner.

25157 (FE—2729-9) **Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, September 21-December 20, 1979.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 5 Jan 1980. Contract EF-77-S-01-2729. 23p. NTIS, PC A02/MF A01.

Tests for catalyst deactivation by carbon deposition in a Berty reactor showed that CO partial pressure exerted a greater influence on deactivation than H_2 partial pressure. In kinetic studies in which H_2O vapor was added to the reactant gases, H_2O was found to inhibit the methanation reaction. H_2O inhibition was found to increase with temperature and loss of activity was observed at H_2O/CO ratios greater than one. The order of methanation with respect to H_2 and CO varies over the range of temperature from 498 to 598°K. Rate data indicate a change in mechanism or rate determining step at higher temperatures. Our experience with a quartz CFSTR has shown that this reactor is very delicate and needs near constant attention to maintain proper working order.

25158 (FE—2729-10) **Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, December 21, 1979-March 20, 1980.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 5 Apr 1980. Contract EF-77-S-01-2729. 43p. NTIS, PC A03/MF A01.

During CO adsorption on nickel catalysts at room temperature, significant amounts of $Ni(CO)_4$ were observed to have formed. H_2S poisoning increased $Ni(CO)_4$ formation. In methanation kinetic tests, H_2O vapor severely inhibited the reaction. In some cases H_2O vapor deactivated nickel catalysts. In poisoning studies it was determined that H_2S adsorption on Al_2O_3 is very significant; thus H_2S deactivation rates were measured in INCO nickel powder. Ruthenium has an apparent activation energy for methanation of 113 kJ/mol. Considerable deactivation is observed at 600°K and above. If deactivation of the catalyst is considered, there is no shift in apparent activation energy over a wide range of temperature as was seen on Ni.

25159 (FE—2798-70) **Test and evaluate the TRI-GAS low-Btu coal gasification process. Interim report, October 1978-September 1979.** (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Nov 1979. Contract ET-78-C-01-2798. 131p. NTIS, PC A07/MF A01.

A total of 14 PEDU tests were conducted, eight with Rosebud seam coal (a non-caking coal) and six with Illinois No. 6 seam coal (a mildly caking coal). The first nine tests were concerned with the operation of the Stage 3 reactor. During the last five tests, the system was operated with the char and gas flows integrated in the process design mode. Smooth transfer of both char and gas between reactors was accomplished. Several minor equipment problems were encountered, but these will be alleviated through modifications. Installation of electric heaters in each of the reactors were made to balance heat losses and obtain a system capable of achieving optimum operation of the process. Small-scale laboratory experiments and analytical studies were conducted to support the PEDU experimental program. Fluidization characteristics were determined in full-scale and small, cold-flow fluidization models. Devolatilization and gasification reactions were studied in small-scale differential and fluidized-bed reactors. Mathematical models of the TRI-GAS process were developed to help predict PEDU performance.

25160 (FE—2806-5) **Coal gasification pilot plant support studies. Quarterly report, April 1-June 30, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). Jan 1980. Contract ET-78-C-01-2806. 162p. NTIS, PC A08/MF A01.

The experience gained in the operation of various pilot plants helped to formulate support study tasks and their objectives. In turn, support studies should develop the basis for improving pilot plant

operation, achieving expected conversion, and effecting cost savings. Such complementary interaction will continue throughout the program. Within this framework, projects are classified into four tasks as follows: (1) Studies of Gasification Reactions for Improving the Performance of Coal Gasification Reactors; (2) Studies of Fluidized-Bed Reactors in Coal Gasification Processes; (3) Studies to Improve the Processing Techniques of Product and Waste Gases from Coal Gasification; and (4) Studies to Improve Methods of Feed Preparation for Coal Gasification. Each task is further divided into a number of subtasks dealing with specific aspects of the task. The objectives of the subtasks and their technical progress during the last quarter (April 1 through June 30, 1979) are presented in this report.

25161 (FE—2806-6) **Coal gasification pilot plant support studies. Project 61015 quarterly report, July 1-September 30, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). May 1980. Contract ET-78-C-01-2806. 188p. NTIS, PC A09/MF A01.

Various studies in support of coal gasification include: Devolatilization and gasification of subbituminous coals in helium and hydrogen, catalytic effects of minerals, fluidized bed reactors, shift process catalysts, thermodynamics of Lurgi and HYGAS process, fuel gas purification (removal, recovery or conversion of sulfur and nitrogen components), coal and fuel slurry preparation techniques, reduction of agglomerating tendency, parametric studies, etc. (LTN)

25162 (FE—3031-4) **Design and simulation of a recirculating bed reactor for coal hydrogasification. Linear programming analysis of hydrogasification strategies.** McIver, A.E.; Bierl, T.W.; Gajdos, L.J. (Carnegie-Mellon Inst. of Research, Pittsburgh, PA (USA)). Jun 1979. Contract ET-78-S-01-3031. 178p. NTIS, PC A09/MF A01.

This report describes an initial attempt to examine the implications of the process design on the recirculating bed hydrogasifier (RBR) operating conditions and the efficiency of RBR hydrogasification. The design and simulation of a recirculating bed reactor for coal hydrogasification requires that standards of performance be established for the hydrogasifier's operation. Primarily this means specifying optimal operating conditions - temperature, pressure and carbon conversion; however, it also means identifying the best mechanisms for control of the reactor heat balance - i.e., heat recovery and/or heat addition. Alternate routes to methane production include both direct hydrogenation of coal and methanation of carbon monoxide with hydrogen. In turn, the hydrogen used in each of these reactions can be produced in a variety of ways. Further, heat must be added to these processes by the combustion of carbon. It is obvious that these reactions can be assembled in a multiplicity of ways and still produce methane; however, the key to effective process design is to select an optimal arrangement of these reactions such that a maximum thermal efficiency is achieved. Maximizing the process thermal efficiency implies that a maximum carbon conversion to methane is achieved. Thus, by coupling the process design and the hydrogasifier design to the goal of maximizing thermal efficiency, a mechanism for designing the optimal hydrogasifier emerges.

25163 (FE—3125-12) **Advanced development of a short-residence-time hydrogasifier. Annual technical progress report, government fiscal year 1979.** (Rockwell International Corp., Canoga Park, CA (USA)). 21 Jan 1980. Contract ET-78-C-01-3125. 153p. NTIS, PC A08/MF A01.

Relocation and modification of the subscale hydrogasifier test facility to accommodate longer duration testing was accomplished. A joint decision was made to scale up the previously planned 1/4-TPH system to a nominal 3/4-TPH system. The required adjustments were primarily in the form of line size changes which were implemented during the installation of the process piping. Additional Rockwell-funded modifications to the reactor train support structure and handling capability were made to accommodate the larger reactor pressure vessel, having an 11.75-in. inside diameter. Facility modifications are planned to provide capability for simulated recycle gas feed, and to provide for more representative sampling for improved material balances. The work accomplished during the first year of the program involved three major areas: (1) Completion of in-house parametric trade-off studies to assess the effect of major hydrogasification reactor performance variables on overall process economics. (2) Support to various A-E firms evaluating the Cities Services-Rockwell Coal Hydrogasification Process. The results of these studies were synthesized and an overall plant configuration chosen to take advantage of the unique operating characteristics of the Rockwell flash hydropyrolysis reactor system. A series of overall process economic estimates were prepared to illustrate the potential economic attractiveness of the process. (3) Preparation of A-E work package to solicit an expression of interest for performing the preliminary design of a commercial plant. Proposals received from ten of fourteen firms were thoroughly reviewed, and a first-step rating evaluation was completed.

25164 (FE—3125-18) **Advanced development of a short-residence-time hydrogasifier. Quarterly technical progress report, January 1, 1980-March 31, 1980.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Apr 1980. Contract ET-78-C-01-3125. 152p. NTIS, PC A08/MF A01.

Progress in the development of test facilities for the hydrogasification of coal and peat is described. (LTN)

25165 (FE—14809-1) **Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. Quarterly technical progress report, September 18-December 18, 1979.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 10 Jan 1980. Contract AC01-79ET14809. 24p. NTIS, PC A02/MF A01.

Three catalysts were prepared: 3% Co/SiO_2, 3% Fe/SiO_2, and a 10% cobalt boride on alumina designated respectively as Co-S-101, Fe-S-100, and CoB-A-101. These catalysts were prepared in the following manner: analytically pure $Co(NO_3)_2 \cdot 6H_2O$ and $Fe(NO_3)_3 \cdot 9H_2O$ salts and commercial Cab-O-Sil silica were used to prepare the 3% silica-supported cobalt and iron catalysts. Samples were prepared by simple impregnation to incipient wetness with aqueous metal salt solutions. Several impregnations were necessary to ensure a uniform deposition of the metal salt, each followed by intermediate drying. After the final impregnation, the catalysts were dried in an oven at 355 to 375°K for 24 h. These dried samples were then bulk reduced in flowing hydrogen at a space velocity of 2000 h^{-1}. The temperature was raised during reduction at a rate of 1.5 to 2.0 K/min until 725°K was attained, then held for 12 h. The reduced catalysts were next passivated with 1% air in nitrogen and crushed to a fine powder for use. The cobalt boride on alumina catalyst (CoB-A-101) was prepared under an N_2 blanket in a sealed reaction vessel to avoid the formation of boron oxide, which cannot be reduced in flowing H_2 even at 675°K. Enough alumina was used so that if all the cobalt adhered to the support 18 wt % metal loading would result. From previous experience we estimate a loading of about 10 wt %; this is currently being checked by chemical analysis.

25166 (IITRI-M—6043-5) **Design, engineering and evaluation of refractory liners for slagging gasifiers. Fifth quarterly technical progress report.** Firestone, R.F.; Hales, C.; Greaves, M.J. (IIT Research Inst., Chicago, IL (USA); McKee (Davy) Corp., Cleveland, OH (USA)). Jan 1980. Contract ET-78-C-01-2785. 27p. NTIS, PC A03/MF A01.

Temperatures in slagging gasifiers are in the 2500° to 3300°F range which limits the materials which can be used. In addition the combination of high pressure (up to 1500 psi) with water vapor and the presence of carbon monoxide and hydrogen can present corrosion problems for refractories. The silica in aluminum silicate materials is chemically attacked by hydrogen and may be removed either by formation of volatile silicon monoxide, or hydrosilicic acid, which is leached out and redeposited in another area of gasifier. The action of carbon monoxide on iron compounds in refractories is also disruptive. Low iron, high alumina refractories are the presently preferred materials for coal gasification plants. The atmospheres and other conditions found in vessels used in coal gasification require the use of dense and insulating high Al_2O_3 refractory shapes and castables. Low SiO_2 and low Fe_2O_3 refractories are necessary to resist steam and CO. In processes that involve molten carbonates or where slag may run down walls, fused cast Al_2O_3 is used to avoid corrosion and erosion. However, considerable research is required to establish optimum refractory systems and design methods for slagging coal gasifiers.

25167 (K/CSD/TM—35) **Review of Department of Energy sponsored codes and documentation available from Purdue and Lehigh Universities' process modeling contracts.** Lister, D.M. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Apr 1980. Contract W-7405-ENG-26. 43p. NTIS, PC A03/MF A01.

In mid-1976 Purdue and Lehigh Universities were awarded three-year contracts to develop steady-state and dynamic software simulators that could be used for general-purpose process design and specifically for the simulation of coal gasification and liquefaction plants. The Purdue project had two principal objectives. The first was to construct a modular computer simulation package for the design of coal conversion systems. The second was to use this package to study general coal conversion flowsheet alternatives. Seven general codes and seven models of major components of the modified Illinois Coal Gasification Group (ICGG) process were developed. The object of the Lehigh work was to select, assemble and develop numerical algorithms implemented as computer codes for the dynamic analysis and continuous simulation of the modified ICGG coal conversion plant. Two general-purpose programs and nine models of major components of the ICGG plant were developed. This report presents a brief description of these programs and discusses their availability and performance on the Oak Ridge IBM computer systems.

25168 (METC—8450-T2(Vol.1)) **Coal processing for fuel cell utilization: task IX one-dimensional (streamtube) model for entrained-flow gasifier analysis.** Lewis, P.F.; Finson, M.L. (Physical Sciences, Inc., Woburn, MA (USA)). Oct 1979. Contract EW-78-A-21-8450. 72p. (TR—198A). NTIS, PC A04/MF A01.

A model has been developed to describe the phenomena which occur in entrained flow gasifiers similar to the METC G3 gasifier. This model is a one-dimensional stream tube (plug flow) approximation, and includes finite rate pyrolysis and homogeneous and heterogeneous chemistry. The model also includes radiative and conductive heat transfer, and has the capability of including a distribution of particle sizes. The results of limited calculations with the model are in general agreement with the experimental results, and indicate that finite rate gas phase chemistry and the presence of smaller particles play a significant role in determining the location of the flame within the gasifier. The finite rate gas phase chemistry produces an ignition delay which, if not accounted for would lead to a conclusion that smaller particles do not play a significant role in the gasifier stability. These smaller particles absorb the radiation from the walls of the gasifier and downstream flame front and thus heat and pyrolyze rapidly. These pyrolysis products then ignite and generate the flame front. Further work is necessary to improve the model to include interactions between particles of different sizes. This work should include computations with particle size distributions wide enough so that the effects of the larger particles on carbon conversion can be assessed. Calculations should then be performed for the range of operating parameters of the METC G3 gasifier for validation.

25169 (METC—8450-T2(Vol.2)) **Coal processing for fuel cell utilization: Task IX one-dimensional (streamtube) model for entrained-flow gasifier analysis.** Cronin, J.F. (Physical Sciences, Inc., Woburn, MA (USA)). Oct 1979. Contract EW-78-A-21-8450. 92p. (TR—1988). NTIS, PC A05/MF A01.

This report contains general instructions for use of OMEGA, One-dimensional (Streamtube) Model for Entrained-flow Gasifier Analysis. It is intended as a companion to Volume I, which describes in detail the equations employed by the code. These instructions will familiarize the user with the input/output aspects of the code. Appendix A contains a full listing of the computer code as utilized at Physical Sciences Inc. The program, written in FORTRAN, has been fully tested on a Prime 400 Computer. Results of the code are presented in Volume I.

25170 (MIT—79TR5) **Assessment of Synthane mechanical equipment.** McCabe, J.T.; Kramberger, F.E.; Hao, B.R.; Dubis, D.; Carson, S.E. (Mechanical Technology, Inc., Latham, NY (USA)). May 1980. Contract AC01-77ET10622. 157p. NTIS, PC A08/MF A01.

The objective of this report is to provide a base-line condition assessment of the key equipment of the synthane process pilot plant based on a historical review of performance, vibration monitoring and a preliminary systems analysis. The historical review of equipment performance was conducted by reviewing all available maintenance and repair records filed at the Synthane pilot plant, interviewing key Maintenance and Operations personnel and observing repair and maintenance procedures where possible. Field vibration measurements of all major rotating components were made periodically to detect current and approaching equipment problems. An overview of the influence of mechanical equipment on plant performance was provided by a systems analysis. The process equipment was categorized according to subsystem function, design source and application to future-generation plants. The analysis was conducted by examining data from the plant operating log to clarify the causes and implications of important equipment-related events. The results of this base line condition assessment of the key equipment at the Synthane pilot plant emphasize the need to expand the objectives of future pilot and demonstration plants and provide for the following recommendations: include equipment performance and reliability objectives as an integral part of the operational program; maintain an effective maintenance and repair data-collection system; conduct comprehensive equipment-failure analysis; establish structured corrective action procedures with high-level disposition; and conduct concurrent systems analysis and provide feedback to plant operations. The incorporation of these recommendations in future pilot and demonstration plants will yield major cost benefits in the operating phases of these programs and in future commercial plants.

25171 (MLM—2731(OP)) **Princetown I data analysis.** Agarwal, A.K.; Zielinski, R.E.; Seabaugh, P.W. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 14p. (CONF-800716—2). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

An underground coal gasification (UCG) field test in bituminous coal was successfully completed near Princetown, West Virginia. This test was performed by US DOE's Morgantown Energy Technology Center with Mound Facility providing the major instrumental and field crew support. The primary objective of this field test was to determine the viability of the Linked Vertical Well (LVW) technology to recover the 900 foot (275 m) deep, 6 foot (2 m) thick coal seam. A methane rich product gas with an average heating value greater than 200 BTU/SCF (7452 KJ/m^3) was produced at low air injection flow rates during the initial phase of the test. This high methane content has been attributed to the nature of the bituminous coal which has a very high volatile matter content. The methane formation can be accounted for by thermal and hydrocracking of tars and oils along with hydropyrolysis and hydrogasification of coal char. The high heating value of the gas was the combined effect of residence time, flow pattern, injection flow rate, injection pressure and backpressure. Thermocouple data have been used to speculate on the path development and the effects of conduction and convection model on the test system. During the gasification phase, a gas with an average heating value of approximately 124 Btu/SCF (4620 KJ/m^3) was produced which resulted in an average estimated energy production of 510.9MM Btu/day (539.1 GJ/D).

25172 (NCEI—0014) **Preliminary analysis of the reductagas coal gasification process. Final report, June 15, 1978-January 1, 1979.** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). 1979. 61p. NTIS, PC 04/MF A01.

A preliminary evaluation of the Reductagas process for coal gasification has been completed. Estimates of capital and operating costs are summarizied. Estimates of capital and operating costs are summarized. These estimates are for complete plants which require only electric power and a supply of raw materials for self-sustaining operations. A graphic description of the effect of plant capacity on manufacturing costs is also presented to facilitate interpretation of these findings. Within the limitations of the assumptions and data used in this evaluation, none of the cases considered are competitive with fuel oil at current prices. Further, there is only a remote possibility that the near-term situation will change even with the benefit of expected technical improvements. In the past, the cost of producing gas has been determined primarily by plant investment. However, the Reductagas process is not as sensitive to this as a partial oxidation type process. In a relative sense, the production capacities considered here are small and the mechanical complexity is high. The combined economic penalties attendent to these conditions are prohibitive. At 2 cents/kwh, the cost of electric power is the largest single direct cost in the Reductagas process. If this cost were reduced to zero, it would still not off-set the above penalties to the extent that competition with fuel oil would be practical. At present, small coal-fed gas producers are not a competitive way for North Carolina industry to obtain their clean fuel requirements. A preferred way of supplying this need might be to gasify peat at a large central station, convert the fuel gas to substitute natural gas (SNG) by methanation, and market the SNG product to individual industries through the existing natural gas distribution system. The benefits attendent to such a scheme are described.

25173 (SAN—1429-56) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 14, July-September 1979.** Slater, M.H. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 19 Oct 1979. Contract EF-77-C-03-1429. 31p. NTIS, PC A03/MF A01.

This project includes the design, construction, and operation of a PDU which will convert 1 ton of coal per hour into low-Btu gas. During the period covered by this report, Monofrax A blocks for relining the gasifier were received, and 5 courses of blocks of the 14 courses required for the full liner had been installed. Details were completed and all parts were fabricated for the melt withdrawal system modifications designed to increase the reliability of the system. The fabrication of pressure-rated gas burners for the melt withdrawal system was initiated. These heaters will operate over the entire pressure range of PDU testing; i.e., from one atmosphere through 20 atmospheres. Detailed test planning and minor plant modifications were carried out in preparation for PDU Test 4. The objective of this test is to demonstrate operations up to 10 atmospheres and at coal feed rates up to 1 ton per hour.

25174 (UCRL—50026-79-3) **LLL in situ coal gasification project. Quarterly progress report, July through September 1979.** Aiman, W.R.; Donohue, M.L. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Dec 1979. Contract W-7405-ENG-48. 44p. NTIS, PC A03/MF A01.

The Hoe Creek No. 3 field experiment was the primary activity. The experiment lasted 37 days and consisted of three phases: reverse combustion, air burn, and oxygen-steam burn. It was necessary to enrich the injected air to 31% oxygen to promote reverse combustion in the directionally drilled borehole linking the vertical process wells. The reverse combustion was completed in 16.5 h for a rate of 44 m/d. During the air burn, 173 m^3 (257 tons) of coal were gasified, which produced 33.5 x 10^6 mol (28.0 x 10^6 scf) of dry product gas with an average composition of 14% H_2, 2.5% CH_4, 11% CO, 14% CO_2, and 56% N_2, and with a heat combustion of 102 kJ/mol (115 Btu/scf). During the (oxygen-steam burn, 3138 m^3 (3177 tons) of coal were gasified, which produced 193 x 10^6 mol (161 x 10^6 scf) of dry product gas with an average composition of 37% H_2, 5.0% CH_4, 11% CO, 44% CO_2, and 2% N_2, and with a heat of combustion of 190 kJ/mol (215 Btu/scf).

25175 (UCRL—84086) **UCG process data base.** Thorsness, C.B.; Cena, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 17p. (CONF-800716—1). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

Process modeling in underground coal gasification (UCG) systems is a useful tool. Often, however, the experimental data necessary to test proposed models and mechanisms is not readily available. To help overcome this problem we describe in this paper a UCG Data Base we are developing to assist in making detailed data from DOE-sponsored field programs easily available. In addition, the data in the current data base are used to summarize the results of the Hoe Creek I, II, and III experiments. A statistical look at these data indicate a general lack of correlation between process variables. A simple gas compositional model is presented and is shown to be consistent with much of the available field data.

25176 (FE—2542-25(Vol.2)) **Phase I: the pipeline gas demonstration plant. Environmental report. Volume 2. Existing environment.** (Conoco, Inc., Stamford, CT (USA)). [nd]. Contract EF-77-C-01-2542. 375p. NTIS, PC A16/MF A01.

Contract No. EF-77-C-01-2542 between Conoco Inc. and the United States Department of Energy requires Conoco Inc. to design, construct and operate a Demonstration Plant capable of converting eastern US Bituminous coals into pipeline quality gas. The main purpose of the project is to demonstrate technology which can produce clean fuels from coal in a safe, reliable, and environmentally acceptable manner. A site consisting of about 1245 acres in Noble County, Ohio, has been tentatively selected for the location of the Demonstration Plant. A comprehensive environmental study and an assessment of the effects of the Demonstration Plant on the environment have been undertaken and completed by Energy Impact Associates of Pittsburgh, Pennsylvania. A six volume Environmental Report covering the environmental study and assessment has been prepared: (1) Project Description; (2) Existing Environment; (3) Project Impact and Alternatives; and (4-6) Environmental Data. This is Volume 2 which describes the present environment for the proposed site for the Demonstration Plant. Data and information on the site topography, geology, soils, seismology, hydrology, water quality, climate, air quality, ambient noise, terrestrial ecology, aquatic ecology, historical and archaeological features, current and projected land use, demographics, and socioeconomic infrastructure are summarized in this volume. In general the proposed site is acceptable for the Demonstration Plant in that the existing environment could permit such a facility.

LIQUEFACTION

REFER ALSO TO CITATION(S) 25129, 25130, 25136, 25142, 25145, 25152, 25165, 25167, 25209, 25212, 25232, 25283, 26086, 26101

25177 (DOE/PETC/TR—80/1) **Heat transfer studies of packed bed coal liquefaction reactors.** Holcombe, N.T.; Knickle, H.N.; Yavorsky, P.M. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Jun 1980. 36p. NTIS, PC A03/MF A01.

The effective thermal conductivity (K/sub e/) and wall heat transfer coefficient (H/sub w/) were determined in a packed bed reactor model over a range of gas mass velocities from 0 to 15,000 kg/m^2 hr, liquid mass velocities from 5000 to 65,000 kg/m^2 hr, and pressures that simulate coal liquefaction pressures from 1000 to 4000 psig. A correlation for K/sub e/ and H/sub w/ was developed for the range of study. Several mathematical models for one and two dimensions, and for one and two parameters, were derived to describe two-phase flow in packed beds. Two flow regimes are described. The entrance effects for the low liquid flow regime seem to be limited to a length of about ten diameters, while the entrance effects for the high liquid flow seem to extend through the entire length of the column.

25178 (DOE/PETC/TR—80/2) **Centrifugation of coal-derived liquids.** Weintraub. M.; Weiss, M.L.; Akhtar, S. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Jun 1980. 72p. NTIS, PC A04/MF A01.

The application of the continuous solid bowl centrifuge to the removal of solids from coal liquefaction products was investigated. The centrifuge removed from 23 to 88% of the input ash from 8 to 73% of the input organic benzene insolubles while flow rates, viscosities, and dam heights were varied. Viscosity μ, effluent liquid rate Q/sub e/, and Ambler's geometric parameter Σ were graphically correlated with attained separations. The separation was relatively insensitive to the variables, as a 50-fold increase in Q/sub e//Σ corresponded to a decrease in ash removal only from 84% to 60% and to a decrease in organic solids removal only from 77% to 22%. Organic solids removal was poorer and more erratic than ash removal because of the lesser density differences and greater size variability of the organics. Ancillary studies demonstrated that coal liquefaction products may behave as a Bingham Plastic fluid, and that this results in an absolute limit on the attainable solids separation. Additional studies showed that little difference in density may exist between the organic solids and liquids, and that effects of aging may threaten the validity of viscosity measurements.

25179 (EPRI-AF—1298(Vol.2)) **Nature and origin of asphaltenes in processed coals. Volume 2. The chemistry and mechanisms of coal conversion to clean fuel. Final report, March 1977-January 1979.** Whitehurst, D.D.; Mitchell, T.O.; Farcasiu, M.; Dickert, J.J. Jr. (Mobil Research and Development Corp., Princeton, NJ (USA). Central Research Div.). Dec 1979. 524p. NTIS, PC A22/MF A01.

Studies have been undertaken to develop a fundamental understanding of the chemistry of coal and coal liquefaction products and the mechanisms involved in the conversion of coal to soluble products under typical solvent refining conditions. Specil emphasis has been placed on the importance and reactions of various solvent components (especially hydroaromatics and phenols), the composition of SRC's, the significance of coal type, the chemistry involved in the formation of insoluble residues, the effects of coal mineral matter, and temperature and contact time variation, especially very short times. A variety of materials were investigated ranging in rank from peat to a low volatile B bituminous coal. Reactions were conducted in stirred autoclaves at contact times of 0.25 to 400 minutes using process-derived and synthetic-recycle solvents. Other reaction variables included temperature, atmosphere, catalysts, and coal pretreatments to alter the mineral constituents. Reactions were also run with coal liquid fractions and model compounds. Solvents included process-derived recycle solvents and chemical fractions isolated from them, as well as synthetic mixtures formulated to elucidate the effects of the nature and concentration of various hydroaromatics and phenols, and the effects of added hydrogen-consuming components. SRC's and solvents were studied by new analytical and preparative liquid chromatographic methods, in addition to a variety of wet chemical and spectroscopic techniques. The compositions of solvents, SRC's and residues were also studied by Field Ionization Mass Spectroscopy, CP-^{13}C-NMR, Polarography, Selective Oxidation, and Optical Microscopy.

25180 (ERII—800-0114) **Temperature profiles in donor solvent liquefaction. Quarterly technical report No. 6, December 1979-February 1980.** Grotegut, D.A. (Eyring Research Inst., Provo, UT (USA)). 1980. Contract ET-78-C-01-3047. 44p. NTIS, PC A03/MF A01.

Work during this quarter consisted of: (1) performing 23 additional autoclave runs including 19 runs at a solvent to coal ratio of 2.5; the lower solvent/coal ratio caused operational problems; (2) SESC runs were made on all autoclave samples following distillation; mechanical problems on the detector caused some difficulty; (3) the math model was run on an initial set of data and was found to need modification; (4) the computer software for the math model was rewritten to run on an inhouse computer rather than a time share facility; and (5) analytical results are incomplete due to time and financial restrants of the contract.

25181 (FE—1800-45) **Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Final report.** Succop, D.C.; Wynne, F.E. (Gulf Research and Development Co., Pittsburgh, PA (USA)). Mar 1980. Contract EX-76-C-01-1800. 98p. NTIS, PC A05/MF A01.

The intial objective of this project was to investigate an advanced process for the conversion of coal to synthetic gasoline and other distillate motor fuels, by delayed coking of a coal/petroleum resid slurry with an associated displacement of petroleum residual to the Fluid Catalytic Cracking Unit. The coking process met or exceeded technical and economic predictions. Ambient pressure coking experiments with two different coal slurries demonstrated synergistic increases in C_5+ distillate yield and product quality. Slurry viscosity measurements and heater fouling tests indicated only slightly pseudo-plastic slurry behavior and no unusual pumping resistance or pressure drop in slurry heaters. However, above 814°F rapid coking and heater fouling was experienced. Laboratory hydrogen transfer mechanism studies led to the conclusion that no C-C transfer occurred during coking. The process appears to be that of general H-H scrambling, perhaps promoted by the presence of a metal reactor and/or coal mineral matter functioning as a catalyst. A profitable coal slurry coking process could be obtained under circumstances in which a high-sulfur (about 4%) fuel oil could be marketed, excess FCC and Alkylation unit capacities would be available due to feedstock shortages, or an improved metals-tolerant FCC catalyst (or a low metals FCC feedstock) would be available. Coking was experienced in only one of the original screening runs. Other runs at 2200 psig system pressure did not foul at inside wall temperatures as high as 988°F with similar heat flux levels. However, plugging was seen at these temperature levels when the heat flux was increased to design levels. A DOE review of their needs indicated that the remainder of the contract time and money should be redirected to a study of hydroliquefaction slurry heating.

25182 (FE—2031-15) **Chemistry and structure of coal derived asphaltenes and preasphaltenes. Quarterly progress report, October-December 1979.** Yen, T.F. (University of Southern California, Los Angeles (USA)). 1979. Contract EX-76-C-01-2031. 14p. NTIS, PC A02/MF A01.

The solvent refined coal liquid from the Pittsburg and Midway Coal Mining Company pilot plant located at Fort Lewis, Washington, has been received and separated reproducibly by the standard solvent fractionation method into three fractions. The coal liquid received is so-called stripper bottom product from SRC-II mode. Table I shows the coal liquefaction reaction conditions and the composition of the products. The 300 cc autoclave system equipped with injection loading, withdrawal systems, and the temperature controller, described before, was used as the reaction vessel. In most reaction studies, tetralin was used as a transport vehicle oil. It was used also for donating hydrogen to the acceptor compounds. Nitrogen gas, instead of hydrogen, has been used for the pressure system, since this simplifies the reaction and gives a clearer picture for the reaction between reactants and solvent. The conversion results on the pentane-soluble (PS) fraction at different conditions are shown in Table III, while the isothermal reaction results on it are in Table IV. With tetralin as a vehicle oil, the results show that only small or negligible amounts of PS are converted into A and BI fractions. However, when PS is pyrolyzed, 26% is polymerized into A and BI fractions. This indicates that tetralin can suppress the formation of A and BI fractions from PS. It is also noted that the composition of coal liquid may change during distillation because of polymerization.

25183 (FE—2038-42) **Expanded bed hydroprocessing of solvent refined coal (SRC) extract. Total reactor pressure and space velocity parameters and short contact time coal extract feedstocks (deashed and non-deashed). Interim technical progress report.** Potts, J.D.; Hastings, K.E.; Chillingworth, R.S. (Cities Service Co., Tulsa, OK (USA). Technology Assessment Dept.). Apr 1980. Contract EX-76-C-01-2038. 105p. NTIS, PC A06/MF A01.

The feasibility of utilizing an expanded bed reactor (LC-Fining Process) for upgrading coal extracts has been expanded to include not only SRC-I feedstock, but also non-deashed/deashed short contact time (SCT) coal extract feedstocks. Another objective of this work was to extend the range of operating variables in the LC-Finer to include operation at higher space velocity and higher total reactor pressure. A given 850°F+ conversion could be attained at various combinations of the operating variables. It was then shown that this 850°F+ conversion became a correlating parameter for gas and liquid product distribution. The expanded range of the operating variables correlated well with data which was previously accumulated at a constant set of operating conditions. Non-deashed SCT PDU runs in the LC-Finer show a different product distribution than PDU runs made with SRC-I. However, deashed SCT showed a similar product distribution at milder operating conditons. SCT PDU runs in the LC-Finer exhibit a higher livel of denitrogenation in the total liquid product.

25184 (FE—2211-11) **Chemistry of lignite liquefaction. Quarterly report, July-September 1978.** Stenberg, V.I.; Baltisberger, R.J.; Kalbunde, K.J.; Woolsey, N.F.; Severson, D.; Souby, M. (North Dakota Univ., Grand Forks (USA)). Oct 1978. Contract EX-76-C-01-2211. 82p. NTIS, PC A05/MF A01.

Various results related to the liquefation of lignite are reported. The structural chemical anaysis of oxygen and nitrogen compounds in coal liquids is facilitated by acetylation. Solvent refined lignite and solvent-refined coal have been hydrogenated using a variety of catalysts. The resulting liquids have been fractionated by distillation and exmined by mass spectroscopy and nuclear magnetic resonance. Model compounds have been reduced using carbon monoxide-water or hydrogen using various catalysts (among others fly ash) in an effort aimed at reducing the severity of coal liquefaction conditions. Finally, electron transfer from thermally activated magnesium oxide powder to nitrobenzene and adsorbed carbon monoxide has been studied. (LTN)

25185 (FE—2233-4) **Catalytic activity of coal mineral matter. Quarterly report, April-June, 1977.** Hamrin, C.E. Jr. (Kentucky Univ., Lexington (USA). Research Foundation). Dec 1977. Contract EX-76-C-01-2233. 33p. NTIS, PC A03/MF A01.

Surface areas were measured using the BET method for nine LTAs, an SRC LTA, and seven clays after they had been used in catalytic activity testing. The coal LTAs, values ranged from 28.9 m^2/g for Illinois No. 6 to 9.0 m^2/g for the Beulah Lignite. Clay surface areas varied from 72.3 m^2/g for montmorillonite 22a to 7.2 m^2/g for illite 35. Three LTAs surface areas were measured before and after testing and were found to be 2.4 to 4.9 times greater after testing. A pulse reactor at 450°C and 239 kPa was used to study the catalytic activity and selectivity of several clays found in coal mineral matter. Of these montmorillonite 22a gave the maximum thiophene conversion of 13% while kaolinite 5 produced the maximum conversion of 33% for n-butylamine. The latter value was higher than that found for silica (7%), cobalt molybdate (20%) or alumina (29%). The clay activity of HDS was correlated with the impurity iron content determined by x-ray fluorescence with an R = 0.995. For HDS the Al/Si ratio and titanium content gave good correlations with R = 0.87 and 0.78, respectively. It was found that even under a hydrogen atmosphere the six clays tested gave primarily butenes from thiophene, pyrrolidine and n-butylamine.

25186 (FE—2233-5/8) **Catalytic activity of coal mineral matter. Final report, January 1976-July 1979.** Hamrin, C.E. Jr. (Kentucky Univ., Lexington (USA). Research Foundation). Jul 1979. Contract EX-76-C-01-2233. 99p. NTIS, PC A05/MF A01.

Nine coals were selected and two sets of low temperature ash samples were prepared. Characterization of the LTAs by x-ray diffraction (XRD), x-ray fluorescence (XRF), thermogravimetric analysis, BET surface area, and pore volume was completed. X-ray diffraction of raw coal samples was also carried out to show that little if any change occurred during low temperature ashing. A table shows the catalytic activity for thiophene HDS at equal final catalyst weights and for n-butylamine HDN on the same basis. These results were obtained at 400°C and 1 atm. A statistical analysis of the HDS conversions versus the XRF values showed potassium to give the best correlation with an R-value of 0.62. An even higher R-value of 0.87 was found for the surface area-conversion correlation. Of the clays tested montmorillonite No. 22 was the most active and its activity exceeded that of the Homestead LTA by 67%. For HDN, surface area also gave the highest correlation followed by the Si and K concentrations. To eliminate the effect of surface area, the HDN results were put on an equal area basis. Correlations were obtained slightly below the 95% confidence level for Al, Si, and Ti. The effect of chemical treatment with HCl, H_2O, KCl, and other solutions on the activity was determined. No significant improvement was found for the former three, but a patent application has been filed for a Ni treatment that increased HDS activity 45 times but left HDN virtually unchanged. Iron sulfide catalysts of high surface area (41 m^2/g) and varying S/Fe were prepared by sulfiding hematite under different time, temperature, and gas compositions. The highest conversion of thiophene was found at an atomic ratio of S/Fe = 0.78. LTA pyrite was also found to have significant HDS activity although its surface area was only 2.4 m^2/g.

25187 (FE—2270-48) **Solvent refined coal (SRC) process operation of solvent refined coal pilot plant, Wilsonville, AL. Quarterly technical progress report, January-March 1979.** (Catalytic, Inc., Wilsonville, AL (USA)). Dec 1979. Contract EX-76-C-01-2270. 132p. NTIS, PC A07/MF A01.

Operating conditions and test results obtained at the six-ton-per-day Solvent Refined Coal (SRC) pilot plant in Wilsonville, Alabama are summarized. Two coals were processed: Kentucky 6 and 11, and Kentucky 9. Both are high-volatile bituminous coal from the Pyro mine. The effects of dissolver volume (space rate), dissolver solids concentration, and feed gas rate on SRC yield and solvent hydrogen-donor quality were determined. A system for withdrawing a portion of the dissolver solids was utilized so that the effects of varying the solids concentration in the dissolver could be investigated. The effects of SRC process conditions and CSD operating conditions on SRC recovery were studied. Recovery of SRC in the Kerr-McGee Critical Solvent Deashing (CSD) unit improved when the dissolver volume was increased. Techniques for cleaning the United States Filter Corporation Vertical-Leaf Filter screens were investigated to provide a basis for redesign of the filter sluicing system. Laboratory-scale filter precoat tests were also made to determine the optimum screen type and mesh.

25188 (FE—2307-61) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Project 61001 third quarterly report, October 1-December 31, 1979.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, IL (USA)). Apr 1980. Contract EX-76-C-01-2307. 43p. NTIS, PC A03/MF A01.

Work effort was directed towards operating the process development unit (PDU). The solids-feeding system was improved through minor changes to obtain design capacity feed rates. Additional problems surfaced, particularly with the oxygen injection assemblies, which will require modification of equipment and operating procedures. These modifications are currently being tested. A summary of a detailed sizing result and design of a commercial riser cracker has been included under Task 6. On the basis of this design, a capital cost investment is shown. Annual operating costs have been developed and, together with capital charges, have been applied to develop the cost of gas, gasoline, and heavy fuel products. With capital charges based on the standard utility financing method, the price of products was as follows: gas, $3.76/million Btu; gasoline, $0.86/gallon; and No. 6 fuel oil, $0.59/gallon. In bench-scale operations, a larger (-60 + 100 mesh) coal particle size resulted in a hydrocarbon liquids yield lower than that for a power plant grid (75%-200 mesh). Attempts to operate with syngas and steam at high pressure were not successful because of carbon formation.

25189 (FE—2315-48) **Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Quarterly report, October-December 1979.** Sullivan, R.F.; O'Rear, D.J. (Chevron Research Co., Richmond, CA (USA)). Jan 1980. Contract EX-76-C-01-2315. 43p. NTIS, PC A03/MF A01.

Current pilot plant results are presented for processing of H-Coal whole process product derived from Illinois No. 6 coal (Burning Star Mine): first, hydrotreating of the whole oil and, second extinction recycle hydrocracking of the hydrotreated product. The 250°F+ portion of severely hydrotreated Illinois H-Coal whole process product meets the jet fuel specifications for aromatics content, smoke, freeze, and flash points and almost meets the current specification for gravity and end point. The yield of 250°F+ product is 90.4 LV % based on feed. The diesel fuel oxidation stability of 300°F+ hydrotreated products is excellent, even without additivies. A large batch of low aromatic, denitrified Illinois H-Coal whole process product was prepared for downstream hydrocracking. In this preparation roughly 2100 SCF/bbl of hydrogen was consumed by the oil. The whole product from this hydrotreater was then cracked in an extinction recycle hydrocracker to make a 350°F⁻ product. In this hydrocracking step, an additional 800 SCF/bbl of hydrogen was consumed by the oil. Based on very preliminary results, the Wyodak H-Coal whole process product appears to be easier to hydrotreat than Illinois H-Coal. It contains over 1% more hydrogen and, therefore, consumes about 800 SCF/bbl less hydrogen.

25190 (FE—2335-22) **Catalyst development for coal liquefaction. Interim report, January-March 1978.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Engelhard Industries Div.). Apr 1978. Contract EX-76-C-01-2335. 36p. NTIS, PC A03/MF A01.

Eleven catalysts were formulated and prepared to test the following parameters: the effect of pore-size distribution on activity and selectivity; the activity of components other than Co-Mo; the effect of decreasing the Co-Mo content, while maintaining the same ratio of the components; and preparation of larger batches (1 kg.) of previously prepared catalysts to be used in the fixed bed reactor. The physical integrity of catalysts is being measured by determination of crush strength and resistance to abrasion in a rolling-drum test. Initial results show that laboratory preparations are of higher bulk density and greater crush strength, and slightly lower attrition resistance than the H-coal catalyst. Soaking in hot anthracene oil has no effect on attrition resistance. Confirming earlier data, substantial increases in conversion occur with increase in reaction time or catalyst loading. However, asphaltene yield is essentially constant so that the increased conversion is reflected primarily in oil yield. Earlier conclusions that the primary role of the catalyst is to hydrogenate solvent appear to be confirmed. A catalyst with pores over the range of 50 to 1000A gave higher conversions than either one with all pore volume < 50A or with little volume in the 50 to 1000A range and 33% of the pore volume in pores > 1000A. However, the small pore catalyst seems to display the best selectivity to oil formation. A preparation on the 50 to 1000A pore support with half the usual Co-Mo level is virtually indistinguishable from one containing the normal 3 wt % CoO-15 wt % MoO_3 concentration in batch testing. The claim that the Harshaw Ni-Mo catalyst (HT-500) is more selective to oil formation was not substantiated in our test.

25191 (FE—2335-25) **Catalyst development for coal liquefaction. Annual report, July 1, 1977-June 30, 1978.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Research and Development Dept.). Nov 1978. Contract EX-76-C-01-2335. 123p. NTIS, PC A06/MF A01.

The goal of this program is the development of an improved catalyst for coal liquefaction. Catalysts were prepared on a variety of supports to determine the effects of pore-size distribution, support composition, acidity, additives to Co-Mo and active hydrogenation components other than Co-Mo. Experiments were also carried out to attempt to simulate the aging behavior observed in continuous testing and to provide insight into the role of the catalyst in the system. The fixed-bed reactor was commissioned and an operating procedure developed. The unit has operated on coal for thirty-nine hours with no evidence of plugging or ash buildup on the catalyst.

25192 (FE—2335-28) **Catalyst development for coal liquefaction. Interim report, July-September 1978.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Engelhard Industries Div.). Nov 1978. Contract EX-76-C-01-2335. 28p. NTIS, PC A03/MF A01.

Ten catalysts were prepared; five were prepared directly on a very large pore alumina to determine whether pore size was reaction limiting; and five used the same alumina as the support but the alumina was coated with other oxides to provide a chemically different surface, then impregnated with Co-Mo. Surface area and pore size distribution of these preparations were determined. Tests were carried out to determine: (1) the extent of the thermal reaction at temperatures from 445°C to 420°C at 1600 psig; (2) conversion and product distribution over the American Cyanamid H-coal catalyst for 68 h at 420°C and 1600 psig; (3) conversion and product distribution over an E.I. catalyst (10830-31-2) for 165 h at 420°C and 1600 psig. Though the complete work-up of product is not yet completed, coal conversion as measured by benzene solubility is higher for the E.I. catalyst than for the American Cyanamid catalyst. Rates of activity decline were similar for both catalysts. The concept of testing in a fixed bed unit is indeed feasible. When the 165 h run was terminated voluntarily, no evidence of plugging by ash build-up on the catalyst bed could be detected. There is every reason to believe that continuous runs of indefinite duration can be carried out, if desired.

25193 (FE—2494-3/6) **Relation of coal characteristics to liquefaction behavior. Quarterly technical progress reports, January-December 1977.** Given, P.H.; Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Coleman, M.; Painter, P.C. (Pennsylvania State Univ., University Park (USA). Coal Research Section; Pennsylvania State Univ., University Park (USA). Dept. of Material Sciences). Jan 1979. Contract EX-76-C-01-2494. 54p. NTIS, PC A04/MF A01.

A sample base of 111 well characterized bituminous and subbituminous coals from 3 major geological provinces has been assembled. A versatile liquefaction reactor system designed around tubing bombs has been built and used in duplicate conversions with tetralin of 80 of the 111 coals. A start has been made with the study of 60 coals in the Gulf continuous flow reactor. Yields of distillable products and gas analyses are being obtained as well as conversion. The nature of the primary separation of coal liquids achieved on a molecular sieve gel has been investigated as a function of residence time and temperature. Elemental analyses have been obtained, and evidence found of regressive reactions at the longer residence times. The loss of total 0, and 0 as OH and C = 0, has been followed in the early stages of liquefaction of a coal at 5 temperatures and 5 residence times, with conclusions that bear on mechanisms. Detailed petrographic studies have been made of the residues from liquefaction of a coal with tetralin at 2 temperatures and 8 residence times, in order to better understand agglomeration phenomena during liquefaction and to characterize the behavior of different materials. Adsorption isotherms of methanol, benzene and tetralin on 10 coals have been measured at 30, 50, and 70°C. Activation energies for adsorption have been calculated from rates. Comparison of gravimetric adsorption measurements with densities determined in the three liquids show that swelling occurs even in tetralin. Heats of interaction of hydrogen (450°C, 800 psi) have been determined for 25 coals and correlated with conversion in liquefaction. A geochemical study of 30 major, minor, and trace elements in four lignite drill cores and a channel sample of lignite have been completed.

25194 (FE—2494-7/8) **Relation of coal characteristics to liquefaction behavior. Quarterly technical progress reports, January-June 1978.** Given, P.H.; Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Coleman, M.; Painter, P.C. (Pennsylvania State Univ., University Park (USA). Coal Research Section; Pennsylvania State Univ., University Park (USA). Dept. of Material Sciences). Jan 1979. Contract EX-76-C-01-2494. 79p. NTIS, PC A05/MF A01.

Determination in duplicate of conversion in coal/tetralin interactions for 104 coals was completed. Cluster analysis had to be performed to partition the sample set into 3 more homogeneous populations. The groups thus separated showed markedly different ranges of conversion, particularly when some of the same coals were run in the Gulf continuous flow reactor. Multiple regression analyses for the three groups lead to effective predictive equations, each of which called out a different selection of coal properties. It appears that a new classification of coals, more closely related to conversion behavior, is emerging. The experimental and analytical procedures used in the Gulf experiments are described in detail. Runs were at 1000 g slurry per hour at 440 and 455°C, using 3000 psi of hydrogen and a partly hydrogenated anthracene oil as donor solvent. Conversion data for 47 runs on 27 coals are presented. A new theoretical analysis of the kinetics of liquefaction has been performed, starting from the recognition that the process almost certainly involves parallel reactions of a number of differing starting materials. The analysis shows that a change in apparent activation energy with the level of conversion is to be expected, a prediction that is confirmed by experimental data for two of the three coals studied experimentally. The extent and rates of penetration of 10 coals by a number of hydrocarbon vapors, including benzene and tetralin, have been measured at 30, 50, and 70°C; both cause swelling of coals of HVB, HVC, and subbituminous rank classes. The sorption of vapors by coals takes place by several processes, all of them requiring activation.

25195 (FE—2645-04) **Deasphalting, deashing, and upgrading of coal liquids. Quarterly technical progress report, July-September 1979.** Riedl, F.J.; deRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Dec 1979. Contract ET-78-C-01-2645. 30p. NTIS, PC A03/MF A01.

Two complete cycles of Illinois No. 6 Coal liquefaction, followed by solvent deashing of the resultant slurry, and hydrotreatment of the deashed product are described. The cycle is repeated by

using the hydrotreated deashed liquefaction product as liquefaction solvent. Product distribution and hydrogen consumption for the various steps are included.

25196 (FE—2645-05) **Deasphalting, deashing and upgrading of coal liquids. Quarterly technical progress report, October-December 1979.** Riedl, F.J.; deRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Feb 1980. Contract ET-78-C-01-2645. 39p. NTIS, PC A03/MF A01.

Initial work on deashing of the SRC-I filter feed has yielded deashed oil recoveries of 73.2 to 75.5 wt % with an ash content of < 0.001 wt %. The reject bottoms yield ran from 24.5 to 26.8 wt %. The first of three deashed oils derived from UOP coal liquefaction has been catalytically cracked. Conversions of 49 and 56 vol % were obtained. Some of these refined oils have been fractionated and examined by high resolution mass spectroscopy. Numerous aromatic compound classes were identified and are listed in the report.

25197 (FE—2645-06) **Deasphalting, deashing and upgrading of coal liquids. Quarterly technical progress report, January-March 1980.** Riedl, F.J.; deRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Jun 1980. Contract ET-78-C-01-2645. 30p. NTIS, PC A03/MF A01.

Continuing work on deashing SRC-I filter feed has yielded deashed oils containing 0.004 wt % ash or less. The lowest reject bottoms yield was 18.8 wt %. This fails to meet the target of 15% maximum rejection. A summary of the deashing work on SRC-I filter feed has also shown that rejection decreased with use of higher boiling point solvents, with addition of up to 10% light aromatic component to the solvent, and with increased operating temperature. The hydrotreatment of the deashed oil derived from SRC-I filter feed yielded oils containing 9.99 wt % and 10.17 wt % hydrogen. Recoveries of oil ranged from 99.20 to 99.65 wt %. Hydrogen consumption was 1080 to 1090 SCFB hydrogen. Two deashed oils derived from UOP coal liquefaction product have been catalytically cracked. Conversions ranged from 44 to 60 vol %.

25198 (FE—2893-41) **EDS coal liquefaction process development, Phase IV. Quarterly technical progress report, July 1-September 30, 1979.** (Exxon Research and Engineering Co., Florham Park, NJ (USA)). Jan 1980. Contract EF-77-A-01-2893. 372p. NTIS, PC A16/MF A01.

A process variable study with Pittsburgh seam coal was conducted in the 50 pounds-per-day Recycle Coal Liquefaction Unit. Conversions and product yields were higher than previously reported for the 1978 screening study, and could be favorably compared to Illinois No. 6 (Monterey) coal yields. Six yield periods were obtained on Pittsburgh No. 8 coal (Ireland mine) on the one ton-per-day Coal Liquefaction Pilot Plant. Generally good operability was found for this coal. A high severity vacuum flash test was completed on the CLPP to recover liquid products that might otherwide be lost in some bottoms processing operations. For the initial bottoms recycle operations with Illinois No. 6 coal (Monterey mine) on the CLPP, elementally balanced yield data are reported. Liquid yields as high as 36% and conversions of 53% were obtained compared to 32% and 50%, respectively, for coal-only operations at similar liquefaction conditions. Tubing bomb liquefaction experiments with eleven at large coals at 840°F/40 minutes were completed. A wide variation in conversion was observed, especially for coals from different mines of the Appalachian region. Pilot plant hydrotreating studies with Illinois No. 6 and Wyoming fuel oil blends showed that denitrogenation to a 0.2 wt % nitrogen target can be achieved with conventional technology. Hydrogen consumption is high and is proportional to the amount of fuel-bound nitrogen removed. There are concerns regarding long-term catalyst activity, maintenance and operability, since with one feedstock reactor plugging problems were encountered.

25199 (FE—3159-T2) **Aliphatic components of coal. Quarterly report for the period September-December 1979.** Deno, N.C.; Curry, K.; Jones, A.D.; Potter, T.C.; Rakitsky, W.G.; Wagner, K. (Pennsylvania State Univ., University Park (USA)). Dec 1979. Contract ET-78-S-01-3159. 24p. NTIS, PC A02/MF A01.

The elucidation of the structures of coals and coal-derived liquids continues to be a challenging problem on which we are making much progress. Our contributions are somewhat unique at this point in time because of (a) the development of a new method for chemical clevage of coals, (b) the application of our excellent gas chromatography-mass spectroscopy interfacing to previous methods of chemically cleaving coals, and (c) the coupling of these methods to arrive at a coherent view of coal structure. It should be evident that although spectroscopic studies of coals are of great importance, they tend to yield averaged properties and averaged structures. To fully define the structure of coals, they must be chemically cleaved to fragments whose structure can be totally determined. If chemical clevage of coals has been disappointing in the past, it only emphasizes the need for developing cleverer ways of chemically cleaving the coals.

25200 (LBL—9870) **Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction.** Joyce, P.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 107p. NTIS, PC A06/MF A01.

Thesis.

A generalized reactor design is presented for a low-temperature, coal-conversion method, where coal is slurried in an 83 wt % zinc chloride methanol melt and allowed to react at moderate conditions of 275°C and 600 psi hydrogen. The hydrogen being sparged countercurrently at five levels. In the reactor, the slurried melt flows downward in plug flow on the order of 1 foot per minute through a distance of 15 feet. Liquid mass-transfer studies with the model have been undertaken to examine specific effects of zinc chloride in a viscous medium, in order to determine the rate-limiting step in the overall hydrogen absorption rate. The absorption rate can be expressed in terms of a resistance-in-series model. These experiments, interpreted in terms of existing well established correlations involving especially the effects of viscosity, have shown that the use of zinc chloride introduces no new effects and that the chemical reaction rate of the coal particle is controlling.

25201 (METC—78/10) **Survey of valve industry capability to furnish 6" valves for coal conversion processes.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Feb 1977. 193p. NTIS, PC A09/MF A01.

The Morgantown Energy Research Center is proceeding with a program to test and evaluate valves for lockhopper applications in coal conversion processes. The valves shall be of existing state-of-the-art designs or modifications and improvements to such valve designs that can be rapidly implemented. The objective of the MERC State-of-the-Art (SOA) Valve Testing and Development program is to identify readily available valves for lockhopper service in coal conversion processes that can provide reliable service under the severe service conditions of the pilot and early demonstration coal gasification and liquefaction plants. The detailed objectives of the MERC State-of-the-Art Program are: (1) Evaluate the capability of existing off the shelf or slightly modified valves to meet the various lockhopper applications. (2) Generate valve life cycle and failure mode information to aid in establishing repair and maintenance requirements. (3) Generate data for valve design improvements based on experimental testing. The State-of-the-Art Program has conducted a survey to determine vendor capability of supplying valves for use in coal conversion processes. Replies were received from thirty-four vendors of the valve manufacturing and suppy industry. The valves offered by the manufacturers or representatives are described with diagrams and specifications. Based on evaluation of these offerings certain valves are recommended for purchase and testing.

25202 (ORO—5020-7) **Interaction of H atoms with ultrafine coal dust. Final technical report, January 16, 1976-August 15, 1979.** Mains, G.J. (Oklahoma State Univ., Stillwater (USA)). Mar 1980. Contract EY-76-S-05-5020. 60p. NTIS, PC A04/MF A01.

Photoproduced H atoms reacted with coal at temperatures as low as 100°C (and much more vigorously at 200°C). The sites of attack were not at alkane sites or BTX and different for each rank of coal as expected; quite the reverse, the sites of attack appear to be PNA clusters which are rapidly and indescriminately hydrogenated to saturated gasoline-type hydrocarbons (spiked with a little surviving BTX). Unfortunately, photochemically produced H atoms are an expensive way to convert coal into gasoline. When the temperature was raised to 200°C, BTX condensation was no longer a concern. However, when the HPLC analyses suggested pyrene, phenanthrene, and fluoranthene as H-atom cracking products, the investigators were quite startled. In fact, these three and four ring PNA were formed at levels well below their vapor pressure at 200°C, and may only indicate the tip of the iceberg. It is possible, indeed likely, that considerably larger PNA molecules are liberated by H-atoms at 200°C but, because of their very high reactivity, get cracked to these smaller PNA products before they can exit the reactor. It would appear that H-atoms are indeed an effective probe of the coal surface. The surface must contain an increasing number of partially oxidized phenanthrene, fluoranthene (or benzo (b) fluoranthene) precursors as the coal rank increases. Precisely what these structures are can never be inferred from steady state experiments because of subsequent and rapid hydrogenation/cracking. While this study did not provide a final structure for the surface of coal, it surely has eliminated a lot of early postulates, including Given and Wiser's models, at least at the ground and admittedly-altered surface.

25203 (SAND—80-0070) **Tagging of an H-coal PDU run.** Sample, D.G.; Thomas, M.G. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 24p. NTIS, PC A02/MF A01.

A 3.5 lb charge of American Cyanamid 1442A CoMo catalyst was activated in a thermal neutron flux to an overall activity of 390 μCi of ^{60}Co. This catalyst was inserted into H-Coal PDU run No. 9 and subsequent daily withdrawals and the final dump were analyzed

for total ^{60}Co. The mass balance for the experiment was better than 96% based upon ^{60}Co in and out. The activity of ^{60}Co in the withdrawals reached a maximum approximately seven days after insertion of the tag. Activity of the PDU, the cyclone underflow and overflow, offgas, and the vacuum bottoms were monitored continuously during the run. No activity was observed in the gas, and small amounts were detected in the other areas which agreed with predictions based upon 4% attrition. Personal dosimetry and urine analysis indicated that no personnel at HRI involved in the experiment received measurable doses of radiation.

25204 (SAND—80-0500) **Coal liquefaction process research quarterly report, October-December 1979.** Bickel, T.C.; Curlee, R.M.; Granoff, B.; Stohl, F.V.; Thomas, M.G. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract EY-76-C-04-0789. 54p. Dep. NTIS, PC A04/MF A01.

This quarterly report summarizes the activities of Sandia's continuing program in coal liquefaction process research. The overall objectives are to: (1) provide a fundamental understanding of the chemistry of coal liquefaction; (2) determine the role of catalysts in coal liquefaction; and (3) determine the mechanism(s) of catalyst deactivation. The program is composed of three major projects: short-contact-time coal liquefaction, mineral effects, and catalyst studies. These projects are interdependent and overlap significantly.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 25137

BY-PRODUCTS

25205 (BCRA—68) **Thermal analysis of electrode binder pitches.** (British Carbonization Research Association, Chesterfield). Jul 1979. 30p. NTIS (US Sales Only), PC A03/MF A01.

A wide range of materials, but mainly electrode binder pitches, have been examined by various thermal analysis regimes. It has been shown that the thermogravimetric analysis of pitches yields useful results which correlate with those from distillation-type tests and coking value. The TG method has the advantage that it provides data over the whole temperature range of pitch pyrolysis. Carbonization of pitches under conditions which simulate electrode production (i.e., in mixture with coke and using air then nitrogen atmosphere) is also possible. The correlation of TG results (obtained using these conditions) with electrode properties and performance awaits the production of sufficient data. The use of DTG results has been limited in that detailed comparison of DTG plots produced by the electrode pitches is difficult. However, the comparison between straight run and thermally treated pitches was facilitated by examining their DTG plots. No useful results were obtained by differential thermal analysis. Since the method used for combined TG/DTA yields less precise TG results at low mass loss, it is preferable to use straight TG if the HT-F thermobalance is used. The main limitations of the HT-F thermobalance are the lack of complete atmosphere control, the absence of a DTG facility and the insensitivity of the DTA apparatus.

PROPERTIES

REFER ALSO TO CITATION(S) 25124, 25134, 25163, 25171, 25173, 25174, 25194, 25199, 25257, 25270, 25869

25206 (CONF-791160—(Vol.2), pp 37p, Paper 2, Session V) **Characterization and structural studies.** Botsaris, G.D.; Glazman, Y.M.; Adams-Viola, M.; Goldsmith, P.S.; Haber, R.J. (Tufts Univ., Bedford, MA). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The purpose of this paper is to demonstrate that the surface properties of coal, and specifically, its philicity or oleophilic/hydrophilic nature is an important parameter which governs both the aggregative and sedimentative stability, the structure and the rheology of COM. Moreover, it is contended that the surface properties of the coal are not only important in COM which contain additives (surfactants and/or water) but also in those which do not. The rheology and stability properties of various COM formulations prepared with different coals were investigated. Three parameters, a sedimentation number, an aggregation number and a gelation number, were developed to concisely reflect the results of the rheological and stability tests. An attempt was made to develop a model to explain the effect of additives (including water and/or nonionic surfactants) on the structure, stability and rheological properties of COM prepared from coals having different surface properties.

25207 (CONF-791160—(Vol.2), pp 15p, Paper 5, Session V) **Rheological properties of solvent refined coal-oil mixtures.** Foster, E.P.; Gupta, A.S.; Dooher, J.P.; Kelly, C.M. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Combustion of coal-oil mixtures and Solvent Refined Coal solids-oil mixtures are expected to facilitate reduction of US oil consumption. Proper development of technologies to utilize SRC solids-oil mixtures requires an understanding of the preparation, storage, handling, combustion and boiler operation characteristics of such mixtures. SRC solids have less than 0.2 wt% ash and 0.85% sulfur, a high Btu content (15,800 Btu/lb), and are essentially all hydrocarbon material. Thus, SRC-oil mixtures would be expected to have low sulfur and ash emissions, good suspension stability, little erosion problems, and no slagging/deposition problems when used in boiler operations. As the first step in the development, a preliminary investigation of the rheological properties and stability of various mixtures of SRC solid in No. 6 oil and one mixture with No. 5 oil has been carried out. The apparent viscosity was measured as a continuous function of shear rate by a rotoviscometer. Suspension settling stability was assessed by using a pendulum-period technique. The mixtures were found to differ somewhat from coal-oil mixtures of equivalent composition. SRC solid-oil mixtures are non-Newtonian, with an apparent viscosity significantly higher than coal-oil mixtures of equivalent composition. Except for very finely divided SRC particles at low shear rate, all mixtures tested are considered pumpable. There is apparently no significant reaction between SRC solid and the oil, as indicated by a lack of change of viscosity with time. The settling stability varied with mixture composition. Mixtures of SRC solid and oil alone settled somewhat. Mixtures stabilized by emulsification with water or addition of surfactant were felt to be sufficiently stable for commercial use. Of the mixtures tested, an emulsion of 47 wt% SRC solid, 47 wt% No. 6 oil and 6 wt% water is considered the best.

25208 (CONF-791160—(Vol.2), pp 31p, Paper 1, Session VI) **Role of coal and oil characteristics in the stability of coal-oil mixtures.** Ekmann, J.M.; Bienstock, D. (Pittsburgh Energy Technology Center, PA). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Stability in coal-oil mixtures is a complex concept which is a function of many factors. This paper deals primarily with the effect of coal type and oil type on the settling behavior of coal-oil mixtures. Some discussion on the role of dispersion method and addition of water is included. The effect of oil chemistry and viscosity on settling was examined for five No. 6 oils - a correlation was found. Viscosity of the No. 6 oil strongly influenced COM viscosity, while no significant difference was found for several coals. Simple models for the shear stress-shear rate relationship were fit to available data - significant deviations from the models were found for high coal loadings. A simple model for settling is discussed.

25209 (DOE/PC/10346—1) **Ultrasonic characterization of coal liquefaction products. Final report, April 11, 1979-February 11, 1980.** Leffert, C.B.; Weisman, L.; Moore, D. (Wayne State Univ., Detroit, MI (USA). Coll. of Engineering Energy Center). 29 Feb 1980. Contract AC22-79PC10346. 75p. NTIS, PC A04/MF A01.

The Wayne State University ultrasonic device and technique was used successfully to calibrate coal-derived 0 to 45% wt % asphaltene-in-oil mixtures (2 wt % increments) for transmitted signal strength versus temperature (25 to 100°C). Computer-aided cross plots of the transmitted signal strength versus concentration of asphaltene showed that a wide range of concentration and temperature exists where the viscosity-dominated (lower temperature) sound absorption is such that a single-valued number for the concentration of the asphaltene can be obtained from measurement of the sample temperature and transmitted signal strength and thus obtain a measure of the quality of the coal-derived product. Sufficient samples were not provided to obtain a complete calibration of added particulate matter of ash and undissolved coal at all asphaltene in oil concentrations; however, calibrations were made of added ash to three concentrations of asphaltene-in-oil and the data showed the greatest effect at the higher temperatures indicating (as planned) that sound attenuation from Rayleigh scattering is predominant with the suspended particles. We conclude from these two sets of measurements that there is a excellent expectation that the Wayne State ultrasonic device and technique could be used to simultaneously measure (on-line) the suspended particle concentration as well as the quality of the coal-derived product.

25210 (DSE—2750-T1) **Novel approaches to a study of the fundamental organic chemistry of coal. Final report, September 1, 1977-September 1, 1979.** Giam, C.S.; Goodwin, T.E.; Tabor, R.L.; Neff, G.; Smith, S.; Ionescu, F.; Trujillo, D. (Texas A and M Univ., College Station (USA)). 1979. Contract EF-77-G-01-2750. 64p. NTIS, PC A04/MF A01.

The studies are preliminary in nature, and the following conclusions are tentative. (1) The results with mixed carboxylic-

sulfonic anhydrides seem to indicate an increase in polymerization of the coal molecular structure, when based on the results of pyrolysis/gas chromatographic analyses. The mixed anhydrides are such powerful acylating reagents that they should be capable of causing profound and dramatic structural modifications of coal and the results suggest sub-optimal reaction conditions. The results may also be due to the presence of only a small number of ether linkages connecting large molecular units together. Possibly, at elevated pressures and larger concentrations of mixed anhydride, a greater extent of depolymerization would occur, coupled perhaps with acylation. (2) The Nimz lignin degradation reaction has now been fully implemented and good conditions have been found for lignite reaction. The products from this degradation were basically hydrocarbon in nature. Thus, in the absence of monolignols, we postulate that such phenolic linkages of the type found in lignin are not found to a large degree in Texas lignites. (3) Our recently developed technique of analyzing methylene to methyl ratios by IR spectroscopy represents a useful method for characterization of both soluble and insoluble coal-derived products. The technique is less expensive than mass spectroscopy and not limited by solubility as in the case of NMR spectroscopy. (4) From the measurements of the acidic hydrogen content of the lignites studies, we have formed a postulate as to the involvement of heteroatoms (especially oxygen) in the lignite structure. We feel that heteroatoms in Texas lignites are involved mainly in carbonyl, low molecular weight alkoxy and/or heterocyclic units. (5) Conditions for depolymerizing and solubilizing lignites by use of t-butyllithium have been developed and utilized successfully.

25211 (FE—2030-12) **Characteristics of American coals in relation to their conversion into clean energy fuels. Quarterly technical progress report, April-June 1978.** Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Essenhigh, R.H.; Vastola, F.J.; Given, P.H.; Suhr, N.H. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Jan 1979. Contract EX-76-C-01-2030. 51p. NTIS, PC A04/MF A01.

The Penn State Coal Sample Bank was expanded to include four new samples from southwestern Pennsylvania and four from eastern Kentucky. A total of 69 coal samples and 487 selected printouts of coal data were provided to the coal research community. The effects of low temperature oxidation on reducing the agglomerating properties of caking coals are being studied. A DuPont 942 Thermomechanical analyzer has been shown to be a valuable tool for quantifying swelling and softening parameters. In addition, Thermogravimetric studies have shown that oxygen uptake can be followed both quantitatively and reproducibly. From combined TGA, - TMA studies we hope to be able to quantify the effects of preoxidation on the caking properties of coals. Experimental techniques are being developed to study the effect of active surface area of a char on its reactivity during gasification. The effect of preoxidation in air of a highly caking coal in the temperature range 180 to 250°C on weight loss during pryolysis up to 1000°C and reactivity of resultant chars to air have been investigated. Preoxidation has little or no effect on weight loss during pyrolysis. However, preoxidation markedly enhances char reactivity. Important aspects of the chemical and physical makeup of lignite coals are being characterized by x-ray diffraction of low-temperature ashes to determine the mineral content and composition of the coal. Reactivities of a series of chars produced at 800°C from a lignitic coal containing different amounts of exchangeable calcium ions have been measured in 1 atm CO_2 at 760°C. Char reactivity increases linearly with increase in the calcium content of the char.

25212 (FE—2710-10) **Development of industrial methods of analysis of sulfur compounds in coal process streams. Tenth quarterly technical progress report, January-March 1980.** Jordan, J. (Pennsylvania State Univ., University Park (USA). Dept. of Chemistry). Apr 1980. Contract EF-77-S-01-2710. 30p. NTIS, PC A03/MF A01.

The concept of molar distribution coefficients (MDC) has been adapted to computerized estimation of aqueous sulfur moiety concentrations in complex mixtures, as a function of pH, redox potential and temperature. The electrooxidation of tetrathionate was ascertained to proceed with 100% current efficiency at a rotated glassy carbon disk anode. The reaction of hydroxymercury benzoate (HMB) with polysulfides was investigated by thermometric enthalpy titrations. Differential pulse voltammetry at a rotated glassy carbon disk anode has been successfully applied to selectively identify and accurately quantitate dibenzothiophene (DBT) in a DOE-NSF surrogate analysis sample, consisting of SRC II products blended to simulate No. 2 fuel oil. The relevant DBT content was 0.14%.

25213 (FE—3159-T2, pp 1-21) **Dihydroaromatic structure of Illinois No. 6 Monterey coal.** Deno, N.C.; Curry, K.W.; Greigger, B.A.; Jones, A.D.; Rakitsky, W.G.; Smith, K.A.; Wagner, K.; Minard, R.D. (Pennsylvania State Univ., University Park). Dec 1979.

In Aliphatic components of coal. Quarterly report for the period September-December 1979.

Coal from the Monterey mine (Illinois No. 6 seam) has been oxidatively fragmented by trifluoroperoxyacetic acid. The major products were acetic, malonic, and succinic acids; benzene di, tri, tetra, and penta carboxylic acids; and two compounds provisionally identified as the epoxides of ethylene tri and tetra carboxylic acids. These products are in best accord with a structure for Monterey coal in which dihydrobenzene units are frequently interspersed in a polymer composed of condensed aromatic chains and clusters. The methyl and hydroxyl substituents complete the dominant pattern.

25214 (ORNL/MIT—306) **Examination of skeletal structure of coal.** Malaty, W.; Friedman, J.H.; Hone, R.W. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

Oxidation of coal by low-temperature oxygen plasma revealed an inherent mineral network void of organic matter. The potential applicability of this technique as a means of characterizing coals was evaluated by testing the simplified overall gas-solid reaction models developed by Yagi and Kunii. Clarain, vitrain, and durain lithotypes obtained from Illinois, Kentucky, and Wyodak coals were examined. Only the durain coal sample oxidized uniformly. The process was diffusion-controlled for large block samples, but no conclusions could be reached for the powder samples. Limited experimental accuracy and nonuniform oxidation of the clarain and vitrain samples render this method infeasible for general characterizations of coals.

25215 (SAND—79-2016) **Analysis of minerals in coal.** Stohl, F.V. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 43p. NTIS, PC A03/MF A01.

The objective of this work was to determine the sources and magnitudes of the errors associated with the analysis of mineral matter in coal. A radio-frequency low temperature asher was used to determine the quantity of mineral matter in the coal and to separate the mineral matter from the organic portion of the coal for subsequent analysis. The most important variable in low temperature ashing was the radio-frequency power setating, since this determined the temperature at the coal-oxygen plasma interface. A radio-frequency power setting of 15 watts/chamber gave a temperature of 135°C. The qualitative and quantitative analyses of the minerals in the low temperature ash were carried out by x-ray diffraction techniques. The minimum detection limit for a phase was considered to be about 3 wt %. Quantitative x-ray diffraction analysis of the minerals quartz, calcite, pyrite, and kaolinite was carried out by the use of a series of standards made up of varying concentrations of these minerals in a clay matrix with NiO as an internal standard. Under optimum conditions, such as the analysis of samples with no preferred orientation of particles and the analysis of all samples in a single laboratory, the expected error bracket was +- 10% relative. However, the low temperature ashes analyzed in this work contained 40 to 50 wt % clay minerals which have high preferred orientation effects, and the analyses were carried out in three laboratories, so that the error bracket obtained was +- 20% relative.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 25125, 25232, 25270, 25876, 25877, 26076

25216 **Energy recovery system.** Moore, A.S.; Verhoff, F.H. US Patent Application 025,639. [n.d.]. 14p.

The present invention is directed to an improved wet air oxidation system and method for reducing the chemical oxygen demand (COD) of waste water used from scrubbers of coal gasification plants, with this COD reduction being sufficient to effectively eliminate waste water as an environmental pollutant. The improvement of the present invention is provided by heating the air used in the oxidation process to a temperature substantially equal to the temperature in the oxidation reactor before compressing or pressurizing the air. The compression of the already hot air further heats the air which is then passed in heat exchange with gaseous products of the oxidation reaction for superheating the gaseous products prior to the use thereof in turbines as the driving fluid. The superheating of the gaseous products significantly minimizes condensation of gaseous products in the turbine so as to provide a substantially greater recovery of mechanical energy from the process than heretofore achieved.

25217 (BCRA—67) **Investigation into the use of hydrogen peroxide for the purification of carbonization wastes.** (British Carbonization Research Association, Chesterfield). Jun 1979. 20p. NTIS (US Sales Only), PC A02/MF A01.

To study the effect of hydrogen peroxide as a purification agent for coke-oven liquors, in particular for the further purification of effluents treated by the activated-sludge process, various liquors and liquor effluents were allowed to react for different periods with peroxide and the extent of purification determined by simple analytical procedures. It was concluded that: (1) Hydrogen peroxide was not an economical method for the purification of spent liquors but, in

the presence of a suitable catalyst, small amounts of peroxide gave good results with biologically treated effluents. (2) A deterioration in the quality of the biological effluent resulted in an increased peroxide demand. The final effluent was inferior in quality to that obtained when the biological system was functioning efficiently. (3) In the case of a biological effluent from the treatment of a pyrolysis waste, peroxide proved to be the only satisfactory method of further treatment. (4) Reaction time with peroxide is rather slow, which is a disadvantage where large volumes of liquid are concerned. However, polishing processes for some wastes, although expensive, will need to be carried out; in this connection, it would seem that the use of hydrogen peroxide should be competitive with existing processes.

25218 (DOE/EF/2549—36) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly technical progress report, September-November 1979.** Minnick, L.J. (Minnick (L.J.), Inc., Plymouth Meeting, PA (USA)). 1979. Contract EF-77-C-01-2549. 35p. NTIS, PC A03/MF A01.

Because of its visual appearance and chemical composition, it is apparent that recent samples of AFT residue from Rivesville, West Virginia are actually a blend of spent bed residue and fly ash from the boiler. Dry stockpiling of AFT residue results in some reduction in particle size distribution of the material compared to its gradation as received. Preliminary indications are that processing of AFB residue in a conditioning plant, followed by stockpiling for a controlled period and eventual recrushing, may be sufficient preparation for use of the material in structural type applications. Data from the study of expansion bars and test pads show that, for compositions in which the ratio of AFB residue to fly ash is less than 3:7, linear expansion is within generally acceptable levels, whereas compositions in which the ratio of AFB residue to fly ash is in excess of 2:1 show continued expansion in excess of tolerable limits over an extended period of time. The results of laboratory tests of concrete mixtures made with blended cements containing milled AFB residue have shown that detrimental volume expansion and increased water requirements, along with reduced strength development, are characteristic of these mixtures. On the basis of these observations, the use of blended cements containing AFB residue do not appear to be well suited for the production of Portland cement concrete. Stabilized trade wastes sludge samples must have a sufficient amount of additive (AFB residue ad fly ash) to result in a solids content in excess of 50% in order to develop a measurable amount of compressive strength when cured at 100°F. Initial observations of blends of AFB fly ash and spent bed material show that good early strength development can be achieved with an equal weight blending of these materials.

25219 (EPRI-CS—1381) **Comparative economics of advanced regenerable flue gas desulfurization processes. Final report.** Beychok, M.R. (Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1980. 131p. NTIS, PC A07/MF A01.

This study shows that limestone, magnesia and Wellman-Lord scrubbing were the front-running desulfurization technologies as of 1977. EPRI also chose certain less-developed subsystems for further development and possible demonstration. The Atomics International's (now the Rockwell International Corp.) aqueous carbonate process regeneration subsystem, the absorption/steam stripping subsystem, the RESOX sulfur dioxide reduction subsystem, and the catalytic/IFP process were considered for further investigation as a result of this study. The cost estimates show the combination of citrate absorption/steam stripping with Foster Wheeler's RESOX process as an attractive combination. The incentive of a lower-levelized cost than limestone scrubbing (9.6 mills per kilowatt hour versus 10.0 mills per kilowatt hour) plus elimination of a sludge by-product encouraged EPRI to pursue absorption/steam stripping and RESOX development activities. Absorption/steam stripping laboratory tests were recommended as well as a larger RESOX demonstration. Both follow-on efforts were started in 1977 and proved valuable in further developing cost and process information. As a result of EPRI's evaluations, the Atomics International's process was also selected for further development efforts, based on its unique ability to regenerate sodium sulfite and sodium sulfate without using a reducing gas. The EPRI/Niagara Mohawk Power Corp./Rockwell International Corp. aqueous carbonate process pilot testing was started in 1978. This pilot work has helped in developing and evaluating this technology. Generalized cost estimates such as these are only an aid in planning either a research program or the selection of an FGD process. These estimates are best used as comparisons developed on a specific set of assumptions. It is not appropriate to generalize these comparisons or to assume they represent manufacturers' current selling prices.

25220 (EPRI-FP—1257) **Coal ash disposal manual.** (GAI Consultants, Inc., Monroeville, PA (USA)). Dec 1979. 358p. NTIS, PC A16 MF/A01.

Of the approximately 70 million tons of fly ash, bottom ash, and boiler slag produced by United States utilities in 1978, only 24% was used. The rest was placed in storage or disposal areas. This manual was developed to provide reference information for ash disposal. It is intended to aid in the selection and operation of ash disposal systems with respect to cost considerations and current governmental regulations by furnishing specific disposal criteria, where available, and by outlining methodologies for decision making and cost estimating. Specific topics covered include site selection methodology; ash physical and chemical properties; current disposal philosophies; possible governmental regulations affecting new ash disposal sites; conceptual design of ash disposal systems and estimates of ash quantities; case studies of existing ash disposal sites; monitoring; site reclamation; and cost estimating. References covering these topics and ash disposal site design are included.

25221 (FE—2408-11) **Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, January-March 1979.** Li, K.; Rogan, F.H.; Yen, J.H.; Huang, C.S.; Spencer, J.L. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering). May 1979. Contract EX-76-C-01-2408. 62p. NTIS, PC A04/MF A01.

Rate data was obtained this quarter for sulfidation of uncalcined Guelph dolomite. Initial experiments indicated that dolomite is highly reactive toward H_2S; at 750°C, 100% sulfidation was achieved in less time than required for half-calcined dolomite. The effects of hydrogen on the sulfidation of dolomite and half-calcined dolomite are qualitatively similar. Sulfidation experiments using half-calcined Guelph dolomichemical bonde in simulated producer gas atmospheres were also performed. Although previous experiments had shown that addition of H_2, H_2O, or CO_2 to the feed gas in sulfidation could drastically alter the conversion-time data, the combined effect of the several components of the simulated producer gases was almost negligible. The range of conditions covered by carbonation experiments has been considerably expanded. The initial rate always increases with decreasing temperature, but conversion after one hour shows a maximum near 750°C. Kinetic data for 700°C and above can be fitted to a topochemical model with product layer diffusion and gas film mass transfer jointly rate-controlling. Regeneration of CaO from CaS by high temperature steam proved to proceed rather slowly. The reaction is, however, topochemical. In one experiment the rate was dramatically enhanced by adding a pulse of 2% H_2 to the feed gas.

25222 (FE—2496-42) **Biological treatment of Grand Forks Energy Technology Center slagging fixed-bed coal gasification process wastewater. Eleventh quarterly report.** Luthy, R.G.; Sekel, D.J.; Tallon, J.T. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Center for Energy and Environmental Studies). Mar 1979. Contract EX-76-S-01-2496. 120p. NTIS, PC A06/MF A01.

A wastewater biological treatability study was performed with effluent from the Grand Forks Energy Technology Center slagging fixed-bed coal gasification process. Bench-scale air activated sludge reactors were used to determine minimum dilution requirements, maximum acceptable loadings, biological treatment kinetic coefficients, and other performance characteristics. It was found that ammonia stripped wastewater could be processed reliably at 33% strength at substrate removal rates less than approximately 0.6 mg COD removed/mg MLVSS-day. The wastewater when diluted to 33% strength contained highest reported concentration of organic contaminants in coal conversion effluents processed successfully by air activated sludge. The bacterial yield coefficient for treatment of 33% strength stripped wastewater was 0.29 COD basis, the endogenous respiration rate coefficient was 0.038 day^{-1}, COD basis. Raw wastewater with no ammonia removed could be processed at 40% strength. Nitrification was feasible with both stripped and unstripped wastewater. COD removal rates which impaired nitrification were dependent on ammonia loading, as nitrification could be sustained at higher values of substrate rate with unstripped wastewater than was observed with stripped wastewater.

25223 (FE—2496-43) **Biological treatment of Hygas coal gasification wastewater.** Luthy, R.G.; Tallon, J.T. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Center for Energy and Environmental Studies). Dec 1978. Contract EX-76-S-01-2496. 158p. NTIS, PC A08/MF A01.

An eight month experimental study was performed to assess biological treatability characteristics of Hygas coal gasification process pilot plant wastewater comprised of cyclone and quench condensates. The study evaluated treatability characteristics of ammonia stripped and unstripped wastewater at full strength and at 1:1 dilution. It was determined that minimum pretreatment required for biological oxidation consisted of reducing wastewater alkalinity, and decreasing raw ammonia concentration by dilution or by stripping. Kinetic studies with stripped Hygas wastewater showed the waste could be processed at mean cell residence times varying from 10 to 40 days with hydraulic residence times of 2 to 3 days; the bacteriological yield coefficient was 0.11 (COD basis), and the decay coefficient was 0.02/day. The study also determined correlations for dissolved oxygen uptake, the effect of COD removal rate on zone settling velocity and sludge volume index, removal efficiencies for various constituents, and adsorption isotherms for biological effluent COD on activated carbon and process char. Nitrification was com-

pletely inhibited in this study; it was suspected that this was due in part to high wastewater boron concentration (80 to 110 mg/l), however, additional testing to assess effects of potentially toxic organic compounds is required to confirm this observation. Hygas wastewater seemed to inhibit bacteriological growth because mean cell residence times less than 10 days do not appear feasible and because apparently higher yield coefficients were observed with diluted wastewater. A literature review showed that there are differences in wastewater characteristics between coke plant weak ammonia liquors and high strength coal gasification process effluents.

25224 (SAI—442-810-01) **Report on subtask 1: data gathering, analysis and reporting of scrubber instrumentation survey.** (Science Applications, Inc., McLean, VA (USA)). Mar 1980. Contract EW-78-C-21-8333. 64p. NTIS, PC A04/MF A01.

A variety of in-line instrumentation capable of monitoring typical FGD system variables was found to be on the market. However, little information has been found on instrumentation capable of measuring iron, magnesium, and chloride ion concentration, sulfate and sulfite concentration, and particle size. This indicates that, if these variables are to become typically monitored in an FGD system, then further developments are required to produce applicable in-line instrumentation. Also, more information is required on the specific instruments included in this report before the instrument evaluation of Subtask 3 can be performed. This information will be obtained and presented as a supplementary report.

25225 **Use of oil shale for SO_2 emission control in atmospheric-pressure fluidized-bed coal combustors.** Wilson, W.I.; Snyder, R.B.; Johnson, I. (Argonne Natl Lab, Ill). *Ind. Eng. Chem., Process Des. Dev.;* **19**: No. 1, 47-51(Jan 1980).

Oil shale-SO_2 reactivity, determined with a thermogravimetric analyzer, was used to estimate the quantity of oil shale required to reduce SO_2 concentration in the effluent gas sufficiently to meet the SO_2 emission standard in atmospheric-pressure fluidized-bed coal combustion (AFBC). It was calculated that the oil shale could reduce the SO_2 concentration in the effluent gas from FBC units below the SO_2 emission limit. In evaluating virgin oil shale and spent oil shale for SO_2 emission control, we compared them with (1) Germany Valley Limestone, (2) Greer Limestone, and (3) Tymochtee dolomite. The results indicate that more oil shale than limestone or dolomite may be required to meet the SO_2 emission standard since the calcium content of the shale is relatively low. The attrition rate of Green River oil shale is found to be similar to attrition rates of limestones and dolomites. 9 refs.

25226 **Control technology for coal-fired combustion in northeastern U.S. Part A. Overview and sulfur emissions control.** Ziegler, E.N.; Meyers, R.E. (Brookhaven Natl Lab, Upton, NY). *Water, Air, Soil Pollut.;* **12**: No. 3, 355-369(Oct 1979).

The status of air pollution control technology for coal fired industrial and power plant boilers has been surveyed. Various process capital and annualized costs are reported for SO_2 and particulate removal systems. The status of fluidized bed combustion, fuel desulfurization, conversion of coal to gaseous and liquid fuels, and flue gas denitrification is also discussed. 111 refs.

25227 **Control technology for coal-fired combustion in northeastern U.S. Part B. Particulates, NO/sub x/ and combined systems.** Ziegler, E.N.; Meyers, R.E. (Brookhaven Natl Lab, Upton, NY). *Water, Air, Soil Pollut.;* **12**: No. 3, 371-381(Oct 1979).

Part A of the study described dealt with the existing and proposed pollutant standards and with the control of S emission. This part describes systems for controlling the other major pollutants, particulates and NO/sub x/. Combined removal systems are discussed and conclusions drawn about the status of existing and emerging control technology.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25154, 25224, 25271, 25283, 26299, 26336, 26337, 26348, 26462

25228 (BNL—51137) **Regional Issue Identification and Assessment program (RIIA). Environmental impacts and issues of the EIA MID-MID scenario: Federal Region III (mid-Atlantic).** Brainard, J.; Lipfert, F.W. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). 1 May 1979. Contract AC02-76CH00016. 70p. NTIS, PC A04/MF A01.

The EIA MID-MID scenario generally reinforces existing environmental concerns in the mid-Atlantic region. This results in part from the emphasis on existing rather than new energy technologies. The widespread public opposition to nuclear power in the region is likely to impede realization of the nuclear goals of the scenario. About 50% improvement in sulfur oxides air quality is projected for the region (all states), based on emissions reductions both within the region and in neighboring regions. Even though strip mine production is projected to decrease by 1990, coal production levels hypothesized by the scenario may be significantly constrained by the impact of new Federal regulations on reclamation (Pennsylvania, Virginia, and West Virginia). In the event that offshore oil and gas exploration becomes successful, development may be constrained by continuing opposition on environmental grounds in Maryland and Delaware, relating to protection of coastal environmental resources. Given the abandonment of several recent dam projects in the Delaware, water availability constraints may be important for inland sites where low flow augmentation is required. The health and safety impacts of the scenario are dominated by the coal fuel cycle. By 1990, mining related injuries and deaths are projected to increase by about 25% over current levels, while public health impacts due to sulfur oxides air pollution are projected to decrease by about 40%. Impacts due to other air pollutants, however, were not quantified. Although health and safety impacts due to nuclear power plants in Pennsylvania and Virginia are projected to increase, the numbers are quite small and are likely to constrain the scenario only because of public perception rather than actual risk. Pennsylvania has non-attainment areas (areas where ambient air pollution standards have not been met) which may constrain the siting of new energy-related facilities; one new coal fired power plant may be affected.

25229 (EPA—600/7-79-050a) **Proceedings of the third stationary source combustion symposium. Volume I. Utility, industrial, commercial, and residential systems.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Feb 1979. 259p. (CONF-790338—(Vol.1)). NTIS.

From 3. EPA stationary source combustion symposium; San Francisco, CA, USA (5 Mar 1979).

The proceedings document the approximately 50 presentations made during the symposium, March 5-8, 1979, in San Francisco. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory-RTP, the symposium dealt with subjects relating both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources and to improving equipment efficiency. The symposium was in seven parts, and the proceedings are in five volumes: I. Utility, Industrial, Commercial, and Residential Systems; II. Advanced Processes and Special Topics; III. Stationary Engine and Industrial Process Combustion Systems; IV. Fundamental Combustion Research and Environmental Assessment; and V. Addendum. The symposium provided contractor, industrial, and government representatives with the latest information on EPA inhouse and contract combustion research projects relating to pollution control, with emphasis on reducing NOx while controlling other emissions and improving efficiency.

25230 (EPA—600/7-79-050d) **Proceedings of the third stationary source combustion symposium. Volume IV. Fundamental combustion research and environmental assessment.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Feb 1979. 238p. (CONF-790338—(Vol.4)). NTIS.

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The proceedings document the approximately 50 presentations made during the symposium, March 5-8, 1979, in San Francisco. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory-RTP, the symposium dealt with subjects relating both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources and to improving equipment efficiency. The symposium was in seven parts, and the proceedings are in five volumes: I. Utility, Industrial, Commerical, and Residential Systems; II. Advanced Processes and Special Topics; III. Stationary Engine and Industrial Process Combustion Systems; IV. Fundamental Combustion Research and Environmental Assessment; and V. Addendum. The symposium provided contractor, industrial, and government representatives with the latest information on EPA inhouse and contract combustion research projects relating to pollution control, with emphasis on reducing NOx while controlling other emissions and improving efficiency.

25231 (FE—2542-25(Vol.1)) **Phase I: the Pipeline Gas Demonstration Plant. Volume 1. Project description.** (Conoco, Inc., Stamford, CT (USA)). 1980. Contract EF-77-C-01-2542. 241p. NTIS, PC A11/MF A01.

The main purpose of the project is to demonstrate technology which can produce clean fuels from coal in a safe, reliable, and environmentally acceptable manner. The Demonstration Plant will evaluate new gasification and combined shift-methanation technology. The British Gas/Lurgi slagging gasifier will be used to generate a crude synthesis gas which will be processed into high-Btu pipeline quality gas. The plant is designed to keep gaseous, liquid, and solid emissions to the environment at a low level. A site consisting of about 1245 acres in Noble County, Ohio, has been tentatively selected for the location of the Demonstration Plant. A comprehen-

sive environmental study and an assessment of the effects of the Demonstration Plant on the environment have been undertaken and completed by Energy Impact Associates of Pittsburgh, Pennsylvania. Volume 1 contains a summary of the six volume report, the plant site and layout, the plant construction plan, the plant operating program, plant capital and operating costs, process control and flexibility, and a fault and failure assessment.

25232 (FE—3182-T3) **Waste disposal, cooling and related environmental impacts associated with synthetic fuel plant siting and design criteria.** Goldstein, D.J.; Seufert, F.B.; van Wormer, K.A.; Gold, H. (Water Purification Associates, Cambridge, MA (USA)). Dec 1979. Contract ET-78-C-01-3182. 339p. NTIS, PC A15/MF A01.

This report addresses four problem areas associated with the siting of coal conversion plants in the five major coal bearing regions of the United States. The areas are: the proper choice of cooling and cooling water requirements in coal conversion plants; the selection of energy conservative water environmental control technologies with emphasis on the potential use of the thermosludge process for the treatment of coal conversion foul condensate wastewaters; the selection of waste disposal methods for twenty process-site combinations; and the determination of whether particular conversion processes, products and plant sizes are environmentally more suitable to one site rather than another.

25233 (ORNL/TM—7152) **Overview of the effects of the coal fuel cycle on hydrology, water quality and use, and aquatic ecology.** Cushman, R.M.; Gough, S.B.; Moran, M.S. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

Literature is summarized for the effects of the coal fuel cycle (mining, mine-site processing, transportation, storage, onsite processing, combustion, and waste collection and disposal) on water resources. Aspects considered include surface- and ground-water hydrology, water quality and use, and aquatic ecology. Water use is discussed with regard to both availability and water quality constraints on use. Requirements of the recently enacted Surface Mining Control and Reclamation Act are introduced where appropriate. For the combustion step in the fuel cycle, only those effects which are specific to coal as a fuel are addressed. Effects not specific to coal use (such as thermal effects, impingement, and entrainment resulting from cooling water withdrawal and use) are not considered. Reference is made to more exhaustive studies of the topics reviewed. A summary of the major environmental effects of the coal fuel cycle is given below.

25234 (UCID—18627) **Ground-water hydrologic effects resulting from underground coal gasification experiments at the Hoe Creek Site near Gillette, Wyoming. Interim report, October 1979-March 1980.** Raber, E.; Stone, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 14p. NTIS, PC A02/MF A01.

This technical note summarizes our activities, to date, on the research project: Ground-Water Hydrologic Effects Resulting from Underground Coal Gasification Experiments (EPA-IAG-79-D-X0795). The gasified coal seam (Felix No. 2 coal) and two overlying aquifers (Felix No. 1 coal and overlying sand) appear to have become interconnected as a result of roof collapse and subsidence at both Hoe Creek Sites II and III near Gillette, Wyoming. To evaluate changes in the ground-water flow regime at the two sites, completion of supplementary wells was necessary to define the distance versus head drawdown relationships in each of the three aquifers. Hydraulic head potentials have been measured at Site III since gasification ended on October 10, 1979. These data are presented in graphic format. Although hydraulic head measurements at Site II seemed to be approaching a steady-state condition 1.5 years after gasification, the subsequent gasification at Site III temporarily altered the ground-water flow patterns. These changes will have a definite effect on contaminant dispersal and will need to be taken into consideration.

25235 **The operation of the SRC-II coal liquefaction plant.** *Coal Week;* 6: No. 6, 10(11 Feb 1980).

A news item reports that the operation of this plant, planned for Morgantown, W.Va., may hinge on the construction of the Stonewall Jackson dam. The Monongahela River has almost reached its limit for water usage and there will be insufficient water for the plant in the 1980s unless the dam is completed.

MINING

REFER ALSO TO CITATION(S) 25145, 25258, 25279, 25281

25236 (DOE/CMTC/TR—80-1) **Feasibility of no-proppant stimulation to enhance removal of methane from the Mary Lee Coalbed.** Lambert, S.W.; Trevits, M.A. (Department of Energy, Carbondale, IL (USA). Carbondale Mining Technology Center). Apr 1980. 21p. NTIS, PC A02/MF A01.

One experimental approach to hydraulic stimulation is to use fluid to propagate fractures but not to incorporate solid proppant material in the design. The elimination of solid material negates problems related to wellbore sand proppant influx and allows better fracture height control since extremely low injection rates can be used. The Mary Lee Coalbed was stimulated using a 53,000 gallon no-proppant treatment at a 1,150 foot deep test well located approximately 1,600 feet in advance of mining. The well produced for 147 days and gas flow rates declined sharply, ceasing when intercepted by mining. Production comparison of the no-proppant test with another test incorporating sand proppant indicates that the 53,000 gallon no-proppant treatment was less effective than the more conventional 21,000 gallon treatment. The results from the no-proppant test indicate that very few roof rock fluid penetrations occurred during the course of hydraulic stimulation. It cannot be determined, however, if sparsity of roof penetration was due to the use of very low injection rates or because roof rock in the physical test area was less jointed and, therefore, less prone to stimulation fluid invasions. Because gas flow results gathered are inconclusive, the application of no-proppant stimulation designs for other than research is not recommended at this time. The lower injection rate approach to fracture height control is, however, theoretically sound and because limiting upward fracture growth in coalbeds may be desirable to future borehole gas drainage activities, no-proppant experiments could be justified on a limited scale.

25237 (DOE/ET/8960—T1) **Effects of long-term coal supply contracts on technology adoption and improvements in the mining of coal. Final technical report.** Walton, D.R.; Hawkins, S.A.; Webb, P.F.; Kauffman, P.W. (Management Engineers, Inc., Reston, VA (USA)). Aug 1979. Contract ET-77-C-01-8960. 84p. NTIS, PC A05/MF A01.

The relationship between long-term coal supply contracts and the adoption of new technology in the coal mining industry is a complex one. From this study certain conclusions can be drawn. New technologies and improvements in the mining of coal can be logically categorized into three areas: evolutionary technology, transitional technology, or innovative technology. Evolutionary improvements in technology can be categorized as improvements, or increased production capacities, in existing equipment. Transitional technology involves the adoption of existing or proven technologies into new conditions, or, proceeding from one technology type to a newer type for the same function. Innovative technology includes equipment, concepts, and systems not readily available, or untried, in the existing mining environment (seam conditions, etc.). Technology adoption is an economic decision. This point was repeatedly emphasized by industry representatives contacted during the study. The long-term coal supply contract influences the decision to adopt new technology and mining improvements in several ways depending on the technology type (i.e., evolutionary, transitional, or innovative), and also the coal supplier type (i.e., captive or independent producer). Several examples of the adoption of new technologies in mines under long-term coal supply contracts are discussed. (LTN)

25238 (DOE/ET/10020—T1) **Underground trials of a diesel-powered face haulage vehicle. Final technical report as of November 15, 1979.** Gunderman, R.J. (Dresser Industries, Inc., Columbus, OH (USA). Jeffrey Mining Machinery Div.). Nov 1979. Contract FC01-79ET10020. 88p. NTIS, PC A05/MF A01.

Two four-wheel-drive, articulated, face-haulage vehicles designed and fabricated under a previous government sponsored program were fitted with permissible diesel engines. The vehicles were originally designed for both increased productivity and as test vehicles for steam engine power. The vehicles, with diesel engines installed, were evaluated under operating conditions in an underground coal mine. Results were favorable and demonstrate capabilities in very harsh conditions involving steeply pitching coal seams.

25239 (DOE/ET/10020—T2) **Underground trials of a diesel-powered face haulage vehicle. Final technical report as of November 15, 1979.** Gunderman, R.J. (Dresser Industries, Inc., Columbus, OH (USA). Jeffrey Mining Machinery Div.). Nov 1979. Contract FC01-79ET10020. 88p. NTIS, PC A05/MF A01.

Two four-wheel-drive, articulated, face-haulage vehicles designed and fabricated under a previous government sponsored program were fitted with permissible diesel engines. The vehicles were originally designed for both increased productivity and as test vehicles for steam engine power. The vehicles, with diesel engines installed, were evaluated under operating conditions in an underground coal mine. Results were favorable and demonstrate capabilities in very harsh steeply pitching coal seams.

25240 (DOE/ET/11268—2) **Current longwall ventilation problems and implications for thick seam longwalls. Final technical report.** (Skelly and Loy, Harrisburg, PA (USA)). Jun 1980. Contract AC01-79ET11268. 186p. NTIS, PC A09/MF A01.

The objective of this investigation was to identify, analyze and suggest solutions to ventilation problems of the following mining systems proposed for use in western thick seams; multiple lift longwall; single pass longwall with face height in the range of 12 to 19 feet; longwall sublevel caving. To reach this objective, background information on the regulations and ventilation practices relevant to the three methods was reviewed. This was followed by an identification of ventilation problems including the sources and quantities of methane emissions, respirable coal dust, self ignition and self heating. The problems were then analyzed to determine the probability of occurrence, the cause of the problem, and its consequences. Having analyzed these problems, solutions were described to the problems. The major finding of this effort was that, while certain ventilation difficulties can be isolated peculiar to these three moethods, in general, seam specific conditions have a larger role in determining the success of ventilation than does the method used. The major difficulties to be faced by these novel methods are the same as those to be faced by conventional longwalls. Research efforts should proceed on that basis.

25241 (DOE/ET/11268—3) **General application of the critical path method to resource characterization and planning for underground coal mining. Final technical report.** (Skelly and Loy, Harrisburg, PA (USA)). May 1980. Contract AC01-79ET11268. 287p. NTIS, PC A13/MF A01.

The decision to open an underground coal mine marks the beginning of a complex and costly operation. This report presents the results of the application of the critical path method (CPM) to the total mine planning process. The extensive scope of the process coupled with the complexity of the calculations involved made the use of some form of automation a necessity. Therefore, initial task efforts centered on a search for a satisfactory computer system to enable the handling of the project in a timely fashion. A commercially available CPM software package called SPRED (Solution of the PREcedence Diagram) was chosen. A key prerequisite to the application of CPM was the identification of all of the activities involved in the mine planning process and the determination of all of the interrelationships that exist between them. Results of this work were reproduced graphically in the form of a network diagram. This format depicted all of the activities as labeled boxes in their proper logical sequence of events. Interdependencies were shown by lines connecting the related activities. On its own merit, the network diagram was a valuable tool in conveying a project overview and showing the complexity of the mine planning process. In order to apply CPM techniques to the information generated, each activity was weighted within the context of the entire development project. To accomplish this, an expected duration for completion of each activity was assigned. All of the information necessary for the application of critical path scheduling techniques was produced at this point and the data prepared in the format suitable for input to the SPRED system. SPRED performed all of the critical path calculations and produced appropriate scheduling information. Analysis of the results shows that critical path techniques have definite applicability in mine planning.

25242 (DOE/MC/08089—T4) **Methane recovery from Coalbeds Project. Phase II report and annual report, 1979.** (TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). 1979. Contract AC21-78MC08089. 101p. NTIS, PC A06/MF A01.

Work under the TRW Methane Recovery from Coalbeds Project (MRCP) is defined by three discrete tasks: (1) to provide engineering and technical assistance to the methane from Coalbeds Project in planning, review and analysis of technical proposals, documentation and technical transfer and project evaluation; (2) to provide technical assistance and subcontracting support for resource delineation activities. The objectives of the resource delineation effort are threefold: to estimate more reliably the methane resources contained in the nation's coalbeds; to estimate the recoverable resource; and to determine exploration and production technologies that allow extrapolation from test sites to larger resource areas. Field work in this area is given in the report; (3) to provide design/development analyses, implementation, and evaluations of technology test projects: implementation of a test to demonstrate the recovery of methane from multiple horizontal wells in an active mine and the utilization of the gas for the production of LNG or other purposes; implementation of a test to demonstrate the feasibility of recovering methane from multiple production zones in a single well and utilizing the gas in a local distribution system pipeline; and implementation of a test to demonstrate the feasibility of recovering methane from multiple, vertically drilled wells with multiple production zones in unminable anthracite coal and utilizing the gas by pipeline injection.

25243 (FE—8960-1) **Preliminary analysis of the probable causes of decreased coal mining productivity (1969 to 1976).** Walton, D.R.; Kauffman, P.W. (Management Engineers, Inc., Reston, VA (USA)). 7 Nov 1977. Contract ET-77-C-01-8960-001. 176p. NTIS, PC A09/MF A01.

The concern shown by energy leaders regarding the continuing decline in productivity is not just academic. Rather, it is viewed as a serious threat, not only to the industry but also to the national economy. Recently, a mine operator commented on the productivity decline by saying that the decline does not affect his company because it merely raises the price and then passes the price increase on to the consumer. He felt that, while the mine operator is interested in reducing costs, legislation, labor unrest, and other factors contributing to increased costs are all beyond his control. Although a great many people in the coal industry do not share these views, many do. Therefore, a study of the underlying causes of the decline in productivity is extremely important and is, in essence, truly a national issue. The observation is that as productivity declines, the cost of coal rises proportionally. Obviously the coal industry is in business to make a profit. As conditions change (e.g., more laws are passed, labor unrest increases, and worker attitudes worsen) and resultant productivity declines occur, the costs of coal extraction will increase. Undoubtedly these costs will be passed along to the consumer. The USBM, as a part of an overall effort by the government to solve energy problems, is playing an important role in the coal industry. By identifying the causes of the decline in productivity, it can better direct its efforts in reversing the trend. This can be and is being accomplished by advancing mechanization and developing new technologies in coal mining that better meet the requirements of legislation, improve safety and productivity, and are less sensitive to the impacts of labor unrest, attitudinal shifts, and motivational problems.

25244 (FE—9006-T1(Vol.1)) **Site selection and financial analysis of deep surface mining of anthracite coal. Volume I. Executive summary.** Manula, C.B.; Kiusalaas, J.; Knight, C.G. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 1 Sep 1979. Contract ET-76-G-01-9006. 82p. NTIS, PC A05/MF A01.

This report provides an introduction to the application of open pit methods for mining Pennsylvania anthracite and summarizes the results of economic feasibility studies of open pit mines at two sites: Wabash Valley in the Southern Field and Bear Valley in the Western Middle Field. These sites were selected on the basis of a previous preliminary investigation of five potential sites as providing a range of economic and mining conditions that could be anticipated in open pit mining. The aim at both sites was to determine the economic feasibility of a conventional truck/shovel mine system producing sufficient anthracite to sustain a large power plant. Primary requisites for the design were maximum extraction and environmental clean-up rather than minimized mining costs. On the basis of this analysis the Wabash Valley site appears to have the greater potential for development.

25245 (FE—9006-T1(Vol.2)) **Site selection and financial analysis of deep surface mining of anthracite coal. Volume II. Wabash Valley Site.** Manula, C.B.; Camilli, F.A.; Kiusalaas, J. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 1 Sep 1979. Contract ET-76-G-01-9006. 353p. NTIS, PC A16/MF A01.

The design of a large-scale open pit mine located in the Southern Anthracite Field was evaluated to determine the economic feasibility of this energy resource. A computer model was used to estimate reserves, strip ratios and average mining locations from data provided by the USGS. This information together with equipment performance characteristics was applied to a simulation model to determine truck fleet sizes for shovels and front-end loaders. Capital investment and costs were calculated to obtain a selling price using a discounted cash flow model. Problems of drainage, pit slope stability, overburden characteristics and revegetation are addressed and details of the social and economic background of the area and local land use regulations are given.

25246 (FE—9032-T1) **Continuous operation of longwalls. Final technical report.** (Gates Engineering Co., Beckley, WV (USA)). Aug 1979. Contract ET-76-01-9032. 239p. NTIS, PC A11/MF A01.

The object of this report is to determine the physical and economic feasibility of converting existing longwall operations to continuous operations of four shifts per day, seven days per week. The operating cost of normal operation, detailing labor requirements, capital equipment needs and costing procedures, is compared with the operating cost of continuous operation which includes the additional labor, equipment and facilities required to effect the transition. The effect of the transition to continuous operation on labor, haulage, supply operations, maintenance and surface facilities is analyzed and, where problems exist, solutions are suggested. A description of the experience and results of a continuous operation in England is presented. The study determined that a transition from normal to continuous operation is feasible as far as mine operation and production are concerned. If, however, primary consideration is given to financial justification, and present value return on investment comparison is made with the yield on government securities, then only the transition from normal operation to continuous operation with spare longwall unit in the thick seam model is viable. Return on the same model, when compared with the higher Department of Energy suggested satisfactory return on investment, appears

as unfavorable. These returns on all other models, when compared with either the yield on government securities or the Department of Energy suggested satisfactory returns, appear as unfavorable. If, on the other hand, justification for the transition is based on contributing toward meeting the energy needs of the nation, then the transition in all cases is viable.

25247 Fail-safe control system for a mine methane pipeline. Irani, M.C.; Kapsch, F.F.; Jeran, P.W.; Pepperney, S.J. Pittsburgh, PA; Department of the Interior (1980). 14p. (BM-RI—8424).

The Bureau of Mines has designed and put into operation a fail-safe control system for use in underground coal mines equipped with methane drainage pipelines. This control system can detect certain unsafe conditions and respond by automatically shutting off the flow of methane from the degasification borehole to the drainage pipeline. Methane flow is shut off when the methane content in the return airways reaches a predetermined level (typically 1.5%), when the methane drainage pipeline is ruptured by roof fall, or when there is an electric power failure. The fail-safe control system was designed using commercially available components and a methane analyzer system previously developed by the Bureau. The fail-safe system consists of a unit that combines a shutoff valve and pneumatic valve actuator, and electronic and mechanical equipment designed to detect hazards and effect shutdown. The fail-safe control system was designed to meet regulatory requirements issued by the Mine Safety and Health Administration (MSHA), Department of Labor, and State regulatory bodies for the safe operation of underground methane pipelines used for mine degasification. MSHA has inspected and tested this system and permitted its use in two mines. The Bureau installed the fail-safe system in two working coal mines, where successful performance has been demonstrated.

25248 Reliability, availability, maintainability and safety analysis and optimization of mine power systems. Chinnarao, M. Morgantown, WV; West Virginia Univ. (1979). 270p. University Microfilms Order No. 80-00,215.

Thesis (Ph. D.).

This dissertation builds a failure rate and mean downtime data bank on many mine power equipments, through field data collection from four operating coal mines and through the use of suitable statistical testing and estimation techniques. Markov Process models are then developed and solved in order to assess the reliability, availability and maintainability indices of typical mine power systems. Techniques of optimal spares provisioning for repairable and consumable mine power equipment are developed and numerical examples are presented. A new method of optimal maintenance scheduling is formulated and applied to groups of mine power equipment. A technique for the quantitative assessment of safety in the operation of mine power equipment and life-safety systems is presented, utilizing the basic concepts developed in the Rassmussen Study on the safety of nuclear reactor systems. The results of this dissertation will be useful in enhancing the safety and reliability of coal mine power systems. The methods developed are, in general, expected to be of value in many other fields such as aviation, military systems and rapid transit systems.

25249 (NP—24422) **Future prospects for shotcrete in underground mining.** Ruffert, G. Translated from *Glueckauf*; **112**: No. 21, 1224-1227(1976). 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The shotcreting process which has proved itself in engineering and tunnel construction is assuming increasing importance in the field of coalmining where it is being employed even in deep roads. Here the serviceability of the product depends not solely on the quality and composition of the concrete and on the pressure at which it is sprayed but also to a considerable extent on the operator in charge of the spray gun. The problem of splash-back and dust make which arise during shotcreting can be resolved satisfactorily even in accordance with the special stipulations associated with underground mining techniques. Future development in the field of shotcreting will center around the use of steel-fiber concrete and a study is to be conducted to examine the economic aspects associated with the application of this type of material.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 25134

25250 Process for changing caking coals to noncaking coals. Beeson, J.L. US Patent Application 033,076. [nd]. 15p.

Caking coals are treated in a slurry including alkaline earth metal hydroxides at moderate pressures and temperatures in air to form noncaking carbonaceous material. Hydroxides such as calcium hydroxide, magnesium hydroxide or barium hydroxide are contemplated for slurrying with the coal to interact with the agglomerating constituents. The slurry is subsequently dewatered and dried in air at atmospheric pressure to produce a nonagglometaring carbonaceous material that can be conveniently handled in various coal conversion and combustion processes.

25251 (CONF-791160—(Vol.2), pp 20p, Paper 1, Session IV) **Grinding of coal in oil.** Luckie, P.T.; Bagga, P.S. (Pennsylvania State Univ., University Park). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The work presented in this paper is an extension of work presented at the First International Symposium on Coal-Oil Mixtures. Grinding kinetic parameters were determined, in various fluids, for the coal used in the original study, as well as for two other typical coals. It was found that the breakage action parameters for all of the coals did not change with environment, as previously thought. Measurements of power draw of the test batch mill were also made. The implications of these findings to industrial results are discussed.

25252 (CONF-791160—(Vol.2), pp 29p, Paper 4, Session V) **Production of stable coal-oil mixtures using high intensity mechanical mixing devices.** Stokes, C.S.; Cherry, N.H. (Germantown Labs., Inc., Philadelphia, PA). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The use of four different commercially available high intensity mechanical mixing devices, to produce stable coal-oil-water mixtures, has been investigated. The four types of mixing devices used included a Gaulin Corporation Model 15 Homogenizer, a Sonic Corporation Triplex 1000A, a Branson Sonic Power Model 190 Ultrasonic Processing System and a Total (French) System. The stability of a coal-oil-water mixture up to 45% coal loading was evaluated by a K-scan unit. A detailed description of the parameters and operating conditions for producing the stable mixtures using the four different units is presented.

25253 (CONF-791160—(Vol.2), pp 22p, Paper 4, Session VIII) **Coal/oil mixture pipeline: a viable alternative coal transportation system.** Harkness, J.B.L. (Argonne National Lab., IL); Petrovic, L.J. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Slurry pipeline systems have been promoted as minimizing the environmental and socio-economic impacts of rail transportation and as increasing competition in interstate coal transportation. However, the scarce water resources of the coal rich western states may limit the number and/or capacity of these systems. Furthermore, these systems are not without their own operating and environmental problems. In this paper, a coal transportation system which utilizes coal/oil mixture technology will be compared to the coal/water system and to another alternative, coal/methanol system. The primary considerations addressed here are the system design considerations and trade-offs, the resource requirements (including capital) and the cost of delivered energy. Considerations such as the system environmental impacts, the status of the technologies, oil quality and supply, and the potential system flexibilities will be discussed qualitatively.

25254 (EPRI-CS—1400) **Impact of cleaned coal on power plant performance and reliability. Final report.** Vivenzio, T.A. (Stone and Webster Engineering Corp., Boston, MA (USA)). Apr 1980. 89p. NTIS, PC A05/MF A01.

The potential benefits of coal cleaning to the utility industry include reduced cost of coal transportation and handling, ash handling and disposal, boiler operation and maintenance, and sulfur dioxide and particulate emission control. For many applications, the value of the benefits resulting from improved power plant performance and reliability could be a decisive factor in an economic assessment of coal cleaning. There is a need to quantify these benefits in order to gain more confidence in predictions of cost savings attributed to them. The objective of this study was to quantify the benefits of coal cleaning on power plant performance and reliability through the examination of existing run of mine versus cleaned coal operating data at stations with applicable experience. In addition, the contributions of other studies and papers were summarized to consolidate the most pertinent information on this subject. The conclusion of this investigation is that existing utility operational experience with both ROM and cleaned coal from the same coal source and in the same generating unit is too limited to objectively quantify the benefits of cleaned coal on power plant performance and reliability. More importantly, analyses of the limited experience currently available have shown that a much more significant effort would be required to successfully quantify performance and reliability effects due to coal quality and to specifically quantify improvements gained by coal cleaning. Too many variables can impact the performance and reliability of a power plant. The effects of coal quality can only be quantified by holding the other variables constant, which is likely to be impossible, or by knowing how other variables are affecting performance and reliability in order to adjust the data to isolate changes due only to coal quality.

25255 (EPRI-EA—675(App.1)) **Cost models for coal transportation by common carrier. Appendix 1: User's Manual. Final report.** White, S.J.; Hynes, J.P. (Manalytics, Inc., San Francisco, CA (USA)). Jan 1980. 209p. NTIS, PC A10/MF A01.

This manual provides the technical information needed to operate the computerized transportation cost models developed in EA—675, Cost Models for Coal Transportation by Common Carrier, prepared for the Electric Power Research Institute by Manalytics, Inc., March 1979. Three models were developed: one for rail; one for inland river, Great Lakes, and coastal ocean waterways; and one for origin/destination loading/unloading and for transfer of coal between rail and barge at intermodal trans-shipment points. The models calculate the cost of owning, maintaining, and operating transportation and related equipment, including: propulsion equipment (locomotives or tugboats), load-carrying equipment (hopper cars or barges), crew costs, fuel costs, maintenance costs, other operating costs, and the cost of capital. They offer a variety of operating options, involving unit trains or through trains; towboats dedicated to a set of barges or towboats that swap barges at one or both ends of a trip; train or flotilla size; trip distance; rail terrain; rail regions for wage-rate distinctions; barge trips over open water, over pools behind locks, and through locks; intermodal transfer; and (for deepwater transportation) self-propelled or towed vessels, vessel size and draft, and trip distance. The models use basic technicl performance and cost values developed for our analyses (the default values). Other users, however, can override the default values with their own measures of technical performance and cost. The default values are variable costs, which account neither for overhead nor for profit, although other users may assign overhead or profit to the parameters as needed.

25256 (FE—2694-T3) **Fuel extension by dispersion of clean coal in oil. Phase I. Laboratory feasibility study. Final report.** Burgess, L.E.; Berkof, R.S. (Gulf and Western Advanced Development and Engineering Center, Swarthmore, PA (USA)). 31 Jan 1979. Contract EF-77-C-01-2694. 125p. NTIS, PC A06/MF A01.

This report describes G + W AD & E Center efforts on a DOE-sponsored program to prove the feasibility of a new process to produce a clean, stable, storable, transportable coal-oil mixture. This "CLEANCOM" process includes cleaning, treating, and dispersing coal in oil in an integrated process. The treatment includes the chemical grafting of a water-repellent, oil-compatible polymer coating onto the coal. The feasibility study shows that the CLEANCOM process produces coal with much lower ash, mineral sulfur, and water content. Upon dispersion in oil, the mixture is converted to a thixotropic gel, which has high stability during transportation and storage. Economic studies show that the integrated CLEANCOM process produces less expensive coal-oil mixtures than conventional processes do. This is because the G + W additives are significantly less costly and fewer processing steps are required.

25257 (FE—2722-8) **Effects of minerals on coal beneficiation processes. Quarterly report No. 8 , July 1-September 30, 1979.** McMillan, B.G.; Muter, R.B.; Buttermore, W.H.; Grady, W.C.; Alderman, J.K.; Simonyi, T.; Gierl, D.; Durham, D. (West Virginia Univ., Morgantown (USA). Coal Research Bureau). 15 Mar 1980. Contract EF-77-S-01-2722. 50p. NTIS, PC A03/MF A01.

Work continues at the Morgantown pilot preparation facility to upgrade system components. Batch-scale operations should commence in the next quarter on in-house beneficiation testing of collected samples from the District 3, District 7, and District 10 commercial preparation plants. The remainder of the basic chemical characterization of field samples for the contract also occurred during the report period, and this data (for Illinois No. 6 seam samples) is included in this report. Only the black-water bulk sample for the District 10 plant remains to be analyzed. This sample was processed and submitted for characterization tests. The primary focus of this report period, as documented herein, was on the mineralogical quantitification/semiquantification of the District 3 Pittsburgh seam coal samples. An in-depth discussion of the combined-techniques-mineralogical-quantification (CTMQ) of major coal-associated minerals in this coal, and a review of how standardized equations and data were derived is contained in this progress report. To facilitate presentation of the data, many of the interpretive aspects of the complicated procedure of cross-checking CTMQ techniques are presented in Appendix A and Appendix B. Additional contract documentation for financial and milestone information is presented in Appendix C.

25258 (FE—9033-T2) **Evaluation of alternate hydraulic transport concepts for coal haulage in underground mines. Final technical report.** Szekely, S.M.; Kurz, M.G.; Yegulalp, T.M. (Transflux International Ltd., Fort Lee, NJ (USA)). Nov 1979. Contract ET-76-C-01-9033. 380p. NTIS, PC A17/MF A01.

A cost data bank and two computer programs developed as part of this study allow the user to select an economical pipe configuration for a multi-panel underground coal slurry transport system. The feasibility and controllability of such a system had been proven in previous studies. The programs allow the user to update the data bank and vary otherwise the inputs to meet a wide variety of conditions. Using the programs and a set of predetermined conditions, a number of computer runs were made. These runs selected economic pipe, pump and surge volume configurations for 2, 4 and 8 section mines. It was assumed that one continuous miner operates in each section, with possibly simultaneous full output. One set of runs was based on a set miner cycle time while another on cycles developed by stochastic probability analysis. The first runs were using a system operated with fixed flow rates while the other with variable flows. The second set of conditions offered only insignificant cost advantages for a given configuration. The results indicate considerable cost advantages toward larger and more complex systems using a minimum number of pipe and pumps, since first cost is the overwhelmingly significant cost factor. The effect of size attrition on a coal preparation plant and on plant operations has also been addressed. It was found to increase both complexity and expenses but without significant increase in total mine mouth coal cost.

25259 **The use of crude oil or carbon dioxide to slurry coal.** *Chem. Eng. (N.Y.);* **87**: No. 2, 60(28 Jan 1980).

A very brief news item reports that Arthur D. Little has received a contract from the US Department of Energy to examine the use of crude oil or carbon dioxide to slurry coal or fluidize it for pipeline transport. The use of water for this purpose has raised objections in western states where water is scarce.

COMBUSTION

REFER ALSO TO CITATION(S) 25125, 25206, 25218, 25221, 25283, 25867, 25868, 26007, 26146, 26220, 26242, 26243

25260 (CONF-791160—(Vol.1)) **2nd international symposium on coal-oil mixture combustion.** (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). 1979. 614p. NTIS, PC A99/MF A01.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The state-of-the-art of coal-oil-water mixtures in energy generation is discussed. Processing, transport, and combustion of these fuel slurries are reported. Separate abstracts are prepared for individual items. (DC)

25261 (CONF-791160—(Vol.1), pp 27p, Paper 2, Session III) **Combustion of coal-oil mixtures in a 700 hp watertube boiler.** Pan, U.S.; Bellas, G.T.; Mathur, M.P.; Bienstock, D. (Pittsburgh Energy Technology Center, PA). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Coal-oil mixtures containing up to 50 percent coal by weight have been successfully burned in a 700 hp watertube boiler, designed for oil firing, with no derating occuring. Carbon-conversion efficiencies were above 98 percent, and boiler efficiencies were the same as when firing No. 6 fuel oil. Combustion tests were conducted with No. 6 fuel oil mixed with Pittsburgh Seam coal pulverized to a coal particle size of 90 percent minus 200 mesh. Test results related to boiler performance, pollutant emissions, and ash deposition are presented. The equipment, instrumentation, and data acquisition system of the combustion test facility are described. The modest changes required to adapt the facility designed for oil firing to utilize coal-oil mixtures are discussed. Additional combustion tests needed to assess bottom-ash accumulation and the corrosion, erosion, and fouling behavior inherent in the long-duration operability of coal-oil mixtures in an oil-fired boiler are underway.

25262 (CONF-791160—(Vol.1), pp 32p, Paper 3, Session III) **Test plan for the NEPSCo Coal-Oil Mixture Project.** Foo, O.K.; Jamgochian, E.M.; Sabadell, A.J. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

MITRE, under the sponsorship of the Department of Energy, (DOE), has developed a test plan for use during the demonstration phase of the New England Power Service Company (NEPSCo) Coal-Oil Mixture (COM) project. This test plan was developed in conjunction with the engineering design carried out by NEPSCo, and has been reviewed and coordinated with the Pittsburgh Energy Technology Center (PETC) and NEPSCo. The Electric Power Research Institute (EPRI) has recently joined with DOE and NEPSCo to participate in the project. The overall test objectives include the collection of technical and economic data to evaluate system performance, operability/maintainability, availability/reliability and costs. A continuous 12 month test period has been established. Superimposed on this continuous operating period are four structured test periods. During the structured test periods, the boiler load will be maintained at preselected levels while performance tests on the preparation plant, boiler and ESP are conducted. A large quantity of data will be generated during the 12 month test period. The task of collecting, storing and analyzing this data is a major

effort. The end use of the data will be to provide a technical and economic data base which will satisfy regulatory requirements and contribute to the commercialization of COM technology.

25263 (CONF-791160—(Vol.2)) **2nd international symposium on coal-oil mixture combustion.** (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). 1979. 663p. NTIS, PC A99/MF A01.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

State-of-the-art of coal-oil-water mixtures in energy generation is discussed. The combustion, transport, and processing of these fuel slurries are reported. Separate abstracts are prepared for individual items. (DC)

25264 (CONF-791160—(Vol.2), pp 14p, Paper 3, Session V) **Feasibility study of using a coal/oil/water emulsion and coal/oil mixtures as clean liquid fuels II.** Dooher, J.P. (Adelphi Center for Energy Studies, Garden City, NY); Genberg, R.W.; Moon, S. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The rheological and combustion properties of coal/water/oil mixtures have been investigated. In addition the use of alkaline additives to remove the sulfur oxide gases have been studied. Results on stability and pumpability indicate at mixtures of 50% by weight of coal and stoichiometric concentrations of alkaline absorbents are pumpable. Correlation between viscometer data and pumping data follows a power law behavior for these mixtures. Thermal eficiencies are about the same as for pure oil. Combustion efficiencies are approximately 97%. It is possible to remove in a small scale combustion from 50 to 80% of the sulfur dioxide gases. Data is presented to establish this. Our large combustion facility is described for the testing and evaluation of coal/water/oil mixtures including the use of alkaline additives to remove the sulfur dioxides gases.

25265 (CONF-791160—(Vol.2), pp 15, Paper 2, Session VII) **Development and evaluation of highly-loaded coal slurries.** Scheffee, R.S.; McHale, E.T. (Atlantic Research Corp., Alexandria, VI). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Results of an on-going program to develop and evaluate highly-loaded coal slurry fuels are presented. Slurry fuels comprised of either bituminous, subbituminous, or lignite coal, and either aqueous media or emulsions of No. 6 oil in water as the carrier were developed and evaluated at solids loadings up to 70% by weight. Emphasis is placed on the water slurries of bituminous coal. These slurries were developed for use in place of No. 6 oil in oil-fired burners, and represent a companion concept to COM. High solids loadings were attained by use of bimodal particle size distributions, which are blends of coarse-grind coal (50 to 80% to 50 mesh) and fine-grind coal (generally 90% to 200 mesh). The effect of the blends on slurry viscosity was determined to find the blends that minimize viscosity. The effect of mill conditions on particle size distribution was determined for each coal using a hammermill pulverizer. A large number of water-soluble resins were evaluated for effect on slurry stability and viscosity. Slurries based on the use of 3% solutions of starch in water were prepared with up to 70% by weight bituminous coal and up to 65% subbituminous coal. The slurries are pourable pseudoplastic fluids having room-temperature viscosities in the range of 550 to 1100 cp at a shear rate of 3000 sec^{-1}, depending on the type of coal, solids loading, and particle size distribution. None of the slurries exhibited hardpack settling, even after room-temperature storage up to 74 days. Current effort is being directed at evaluating combustion characteristics of 65% and 70% water slurries of bituminous coal. A 1 MBTHU experimental furnace was designed and constructed which allows heat balances and complete diagnostics to be made of the combustion process. An atomizer/swirl burner unit was designed and fabricated to burn the coal/water slurries. Results of the testing will be reported.

25266 (CONF-791160—(Vol.2), pp 13p, Paper 3, Session VII) **Atomization of coal slurry jets.** Butcher, T.; Pucci, A.; Krishna, C.R. (Brookhaven National Lab., Upton, NY). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

In the atomization of liquids the first step is the spreading of the liquid into thin sheets or columns either by fluid momentum or gas-fluid interaction. The thin sheets or columns will then break up into droplets under the action of surface tension. The simplest case of this is the breakup of a liquid jet, and as a step towards understanding the atomization of coal-oil mixtures this has been studied. The classic work which has been done for liquid jets has been reviewed and repeated in part for coal-oil and coal-water mixtures. Jet length and drop size have been examined for water and No. 2 oil slurries up to 30% concentration. The relevance of this work for atomization is discussed and preliminary data from an air-atomized nozzle is presented for illustration.

25267 (CONF-791160—(Vol.2), pp 15p, Paper 4, Session VII) **Atomization of coal-oil mixtures.** Carmi, S.; Ghassemzadeh, M.R. (Wayne State Univ., Detroit, MI). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

Atomization characteristics of coal-oil mixtures are studied by an experimental set-up consisting of an airblast atomizer fed from a flow control rig, which discharges through a spray channel into a storage tank. Vapors generated are removed via an exhaust system. The fully developed spray is photographed at different axial locations using a 35mm camera fitted with a microflash designed for high speed photography. Slides and prints are analyzed for particle size distribution. For No. 6 oil the distribution is normal with mean particle diameter d of 50 microns. For coal-oil mixtures d increases with the coal concentration. Results will be presented covering the ranges of all operating parameters which characterize the spray formation. Discussion will follow on the potential effect of atomization on combustion efficiency.

25268 (DOE/ET/10660—T1) **Combustion studies of coal-in-oil droplets. Final report, August 1, 1977-July 31, 1979.** Law, C.K. (Northwestern Univ., Evanston, IL (USA)). Dec 1979. Contract FG01-77ET10660. 60p. Dep. NTIS, PC A04/MF A01.

The combustion characteristics of droplets of coal-oil mixtures (COM) were investigated both theoretically and experimentally. Results show that agglomeration of the coal powder occurs upon complete depletion of the volatile oil components, and therefore has serious implications regarding radiation transfer, total burning time, and particulate collection efficiency. Agglomeration is somewhat irrelevant for COM with No. 6 oil because of the small volatility-differentials between coal and No. 6 oil. As a result of agglomeration, fine-crushing the coal is unnecessary unless they can be reduced to micron-sizes such that agglomerate ignition is facilitated.

25269 (DOE/ET/13152—2) **Measuring and modeling solids movement in a large, cold fluidized bed test facility. Second quarterly report, January 1, 1980-March 31, 1980.** Fitzgerald, T.J.; Mrazek, R.V.; Crane, S.D. (Oregon State Univ., Corvallis (USA). Dept. of Chemical Engineering). Mar 1980. Contract AC01-79ET13152. 85p. NTIS, PC A05/MF A01.

The plume model is developed to represent a tube-filled AFBC with large particles, in which air-entrained coal enters in a number of feed ports from below. It assumes that the volatiles are rapidly released from the coal at the feed entry ports to rise as plumes of combustible vapors. Graphs have been prepared to display the predictions of this model for narrow size cuts of a typical coal feed. For a feed of wide size distribution, use these single size charts and properly sum. The lowest carbon efficiency always comes with an intermediate size of feed coal, not with very large or very small feed sizes. Thus the coal feed to the AFBC should try to avoid this critical size. The plume behavior, whether it breaks the surface of the bed, the temperature jump above the bed, concentration variations across the bed, etc., are all governed by one dimensionless group $HD/u_0L_0^2$, which depends primarily on the spacing of feed ports in the bed. For a given coal feed, the carbon efficiency depends only on superficial gas velocity in the bed, the excess air, and elutriation rate constant. A special case and simplification of this model views the coal as being uniformly distributed all over the bed before the volatiles are released. Here analysis is very much simpler, not involving plumes and no volatiles leaving the bed. This plumeless model should reasonably represent AFBC using large feed particles, introduced across the top of the bed and then rapidly mixed by large scale convective flow of solids. The analysis shows that, even in beds with plumes, the simpler plumeless model can be used with negligible error to calculate carbon efficiency; for volatile efficiency, temperature jumps and composition variations across the bed, the complete plume model must be used.

25270 (DOE/PC/10328—T1) **Coal desulfurization during the combustion of coal/oil/water emulsions: an economic alternative clean liquid fuel. Interim report, October 1978-November 15, 1979.** Dooher, J.P. (Adelphi Univ., Garden City, NY (USA)). 15 Nov 1979. Contract AC22-79PC10328. 78p. NTIS, PC A05/MF A01.

The rheological and combustion properties of coal/water/oil mixtures have been investigated. In addition the use of alkaline additives to remove the sulfur oxide gases has been studied. Results on stability and pumpability indicate that mixtures of 50% by weight of coal and stoichiometric concentrations of alkaline absorbents are pumpable. Correlation between viscometer data and pumping data follows a power law behavior for these mixtures. Thermal efficiencies are about the same as for pure oil. Combustion efficiencies are approximately 97%. It is possible to remove in a small scale combustion from 50 to 80% of the sulfur dioxide gases.

25271 (EPA—600/7-79-050b) **Proceedings of the third stationary source combustion symposium. Volume II. Advanced processes and special topics.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Feb 1979. 320p. (CONF-790338—(Vol.2)). NTIS.

From 3. EPA stationary source combustion symposium; San Francisco, CA, USA (5 Mar 1979).

The proceedings document the approximately 50 presentations made during the symposium, March 5-8, 1979, in San Francisco. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory-RTP, the symposium dealt with subjects relating both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources and to improving equipment efficiency. The symposium was in seven parts, and the proceedings are in five volumes: I. Utility, Industrial, Commercial, and Residential Systems; II. Advanced Processes and Special Topics; III. Stationary Engine and Industrial Process Combustion Systems; IV. Fundamental Combustion Research and Environmental Assessment; and V. Addendum. The symposium provided contractor, industrial, and government representatives with the latest information on EPA inhouse and contract combustion research projects relating to pollution control, with emphasis on reducing NOx while controlling other emissions and improving efficiency.

25272 (EPRI-FP—1280) **Materials problems in fluidized-bed combustion systems. IV. Corrosion chemistry in low-oxygen activity atmospheres. Interim report.** Perkins, R.A.; Vonk, S.J. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). Dec 1979. 248p. NTIS, PC A11/MF A01.

This report presents the results of an investigation to evaluate the factors controlling the corrosion behavior of iron, nickel, and cobalt-base high temperature alloys in atmospheres representative of gasified coal. Major factors investigated include alloy composition and surface condition, atmosphere composition, exposure time and temperature, and variable exposure parameters. Thermodynamic phase stability diagrams for the major alloy elements (Fe, Ni, Co, Cr, Al, Mn) with the major oxidants in the gas (C, O, S, N) were derived for use in selecting test conditions and aiding in the interpretation of test results. A transition in behavior from the formation of protective oxide scales to non-protective oxides with overlaying sulfide scales or molten slags was found for all alloys with increasing P/sub $_2$/ or decreasing P/sub O_2/ in $H_2/H_2O/H_2S$ gas mixtures. The failure mode was observed to be the formation of a sulfide scale over the surface of an oxide scale. The nature of this transition from protective to nonprotective behavior has been studied as a function of material and environmental variables. Both thermodynamic and kinetic factors were found to be important. The critical thermodynamic factors are the relative stability of the base metal (Fe, Co, Ni) sulfide for a given sulfur pressure and temperature, and the activity (concentration) of base metal and sulfur ions in the oxide scale. The important kinetic factors are the rates at which base metal ions diffuse or migrate outward to the surface of the oxide scale and the sulfur ions diffuse inward to the scale/metal interface. These factors are controlled by the sulfur activity in the gas in which the oxide is formed.

25273 (FE—1726-42A) **Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power. Phase I. Preliminary engineering. Annual report, March 1, 1977-February 28, 1978.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). 1978. Contract EX-76-C-01-1726. 155p. (CW-WR—76-015.42A). NTIS, PC A08/MF A01.

Work performed to Engineer and Design a Pressurized, Fluidized Bed Pilot Plant using high sulfur coal for production of electric power is summarized. The progress achieved to design the PFB air-cooled pilot plant is described including design of the PFB combustor and the air heat exchanger, the gas turbine and interconnecting hot gas piping, the material handling and the plant control systems. Operation of the plant with the gas turbine decoupled from the PFB combustor was studied as an alternative plant arrangement. An environmental assessment for the construction and operation phases of the pilot plant program was prepared to assure environmental compliance. The results of the technology support tests on atmospheric and pressurized fluid beds burning high sulfur coal are described. Results for air-cooled tube heat transfer performance and for heat exchanger and gas turbine candidate materials erosion and corrosion resistance were obtained. The Small Gas Turbine/Pressurized Fluidized Bed Technology Unit erection was completed and shakedown testing initiated.

25274 (FE—1726-43A) **Engineer, design, construct, test and evaluate a Pressurized Fluidized Bed Pilot Plant using high sulfur coal for production of electric power. Phase I: Preliminary engineering quarterly report, March 1-May 31, 1978.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). 1978. Contract EX-76-C-01-1726. 38p. (CW-WR—76-015-34A). NTIS, PC A03/MF A01.

Technical progress on DOE Contract No. EX-76-C-01-1726 during the period March 1 through May 31, 1978 is described. Technology rigs testing programs are complete and reports documenting metallurgical analyses of hardware evaluated have been issued. The SGT/PFB Technology Unit will be utilized in an extended testing program to evaluate heat exchanger tube and gas turbine component materials. Progress in coal and dolomite feed systems development is discussed. Operational testing of the SGT/PFB unit is summarized and procurement for the extended test program is reviewed.

25275 (FE—1726-44A) **Engineer, design, construct, test and evaluate a Pressurized Fluidized Bed Pilot Plant using high sulfur coal for production of electric power. Phase I. Preliminary engineering. Quarterly report, June 1-August 31, 1978.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). 1978. Contract EX-76-C-01-1726. 63p. (CW-WR—76-015.44A). NTIS, PC A04/MF A01.

Technical progress during the period June 1 through August 31, 1978 on DOE Contract No. EX-76-C-01-1726 is described. Operational testing of the SGT/PFB Technology Unit is discussed. Problems encountered, their probable causes and corrective action recommended are presented. Heat and material balance data from this period of testing are given and initial metallurgical findings from analyses of samples removed at completion of Phase I are summarized. Materials evaluation hardware to be incorporated for the extended program is commented on. Final design of additional components for the Pilot Plant including start-up and auxiliary combustors, J-65 gas generator modifications, power turbine bleed valve actuation system and controls and instrumentation is reported. Status of pilot plant bid package preparation is also noted.

25276 (FE—1726-45A) **Engineer, design, construct, test and evaluate a Pressurized Fluidized Bed Pilot Plant using high sulfur coal for production of electric power. Phase I. Preliminary engineering. Quarterly report, September 1-November 30, 1978.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). 1978. Contract EX-76-C-01-1726. 49p. (CW-WR—76-015.45A). NTIS, PC A03/MF A01.

Technical progress during the period September 1 through November 30, 1978 on DOE Contract No. EX-76-C-01-1726 is described. Additional testing of the SGT/PFB Technology Unit is discussed. Solutions to problems are gradually improving capability of fuel and sorbent flow. Further improvements are discussed. Nine hundred hours of coal feed testing have been accumulated. A new clean-up design is complete and will be fabricated. The Pilot Plant final design made good progress and construction bid packages, containing specifications have been finished. The Pilot Plant Simplified Critical Path Construction Schedule suggested long lead procurement initiation by December 1978 to minimize cost for Pilot Plant completion by reducing construction time.

25277 (FE—2689-T4) **Investigation of fuels containing coal-oil-water emulsions fire tube test apparatus design and construction. Ninth quarterly report, 1 October 1979-31 December 1979.** Cherry, N.H.; Stokes, C.S. (Germantown Labs., Inc., Philadelphia, PA (USA)). Jan 1980. Contract EF-77-C-01-2689. 15p. Dep. NTIS, PC A02/MF A01.

The fire tube test apparatus has been operated at design capacity, 1,000,000 Btu's per hour, using No. 6 Gulf oil. Burner refinements have been made for COM accommodations. The stack gas analysis equipment has been received and is presently being set-up. A test plan is presented for the COM combustion studies.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25244, 25245, 25982

25278 (CONF-791160—(Vol.2), pp 35p, Paper 2, Session VIII) **Market assessment and financial analysis of COM conversion.** Foo, O.K.; Jamgochian, E.M.; Blake, J.C.; Skinner, T.F. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

An investigation was made of the utility boiler market to assess the potential for conversion of oil-fired boilers to coal-oil mixture. A compilation has been made identifying all utility boilers. The critical characteristics such as boiler age, location, pollution control method and generating capacity were included. Oil-fired boilers are further divided into two categories according to their original designed fuel, coal or oil. The oil-designed boilers are separated into two types according to the boiler design features. The distributions of location, age, capacity, and ambient air quality standards of different types of boilers are tabulated. These factors are important in evaluating the COM market and the potential for commercialization of COM technology. A financial analysis of oil-fired utility boiler conversion to COM was also performed. With current fuel prices, conversion to COM is profitable even with the high cost of capital. A considerable increase in coal prices would have to occur at constant oil prices for COM conversion to become financially unattractive.

25279 (DOE/EIA—1073/2) **Annual report to Congress 1978. Volume 2. Data.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 212p. Dep. NTIS, PC A10/MF A01.

National energy statistics are summarized in charts and tables. Sections cover petroleum, natural gas, coal, electricity, nuclear power, solar energy, geothermal energy, and the overall energy situation. Data given for petroleum and natural gas include resources, exploration, development, reserves, supply, disposition, imports, and financial aspects. Coal data cover reserves, production, consumption, supply, and disposition. The electricity section covers fuel use, capacity, production, and sales. The section on nuclear power gives data on uranium resources, power plant status, and the production of electricity. In addition, the report contains a glossary of energy terms, explanatory notes, units of measure, and conversion factors. Many tables provide a history of energy trends over approximately three decades.

25280 (EPRI-EA—1270) **Coal supply alternatives for rural electric G and T cooperatives.** Price, J.; Stauffer, C.H. (ICF, Inc., Washington, DC (USA)). Jan 1980. 364p. NTIS, PC A16/MF A01.

The coal requirements of Generation and Transmission (G and T) rural electric cooperatives are expected to increase by an order of magnitude over the next 20 years. This report provides perspective and an analytic framework for G and T cooperatives to evaluate their individual coal procurement options. It identifies promising coal supply regions and key coal procurement issues, and evaluates alternative types of coal procurement strategies for rural electric G and T cooperatives. Among the topics discussed are economic considerations in the choice of coal-type and supply region, economies of scale, alternative relationships with coal suppliers (e.g., spot purchases, contracts and captive operations), financing coal development, coal purchase contract terms, federal coal leasing, coal transportation, and the impacts of air quality regulations.

25281 (FE—9006-T1(Vol.3)) **Site selection and financial analysis of deep surface mining of anthracite coal. Volume III. Bear Valley site. Final report.** Manula, C.B.; Camilli, F.A.; Kiusalaas, J. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 1 Sep 1979. Contract ET-76-G-01-9006. 172p. NTIS, PC A08/MF A01.

Bear Valley in the Western Middle Anthracite Field of Pennsylvania was evaluated as the site for an open pit mine capable of producing sufficient anthracite to sustain an electric power generating plant. A computer model was used to estimate reserves and stripping ratios from data provided by USGS. This information together with equipment performance characteristics was applied to a simulation model to determine truck fleet sizes for shovels and front-end loaders. Capital investment and costs were calculated and a discounted cash flow analysis was performed to determine rates of return for a range of selling prices. A brief background study of the area is included.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26439

25282 (CONF-791188—1) **Health and coal utilization in the rural South: a cartographic approach.** Calle, E.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From 4. international symposium on computer assisted cartography; Reston, VA, USA (4 Nov 1979).

The implications of coal combustion for populations in rural areas of the south are discussed. Since these communities are not exposed to significant amounts of pollution from sources other than coal-fired power plants, they provide a unique group in which to study the health effects of single-source, local air pollution. Opportunities for research are presented. (DC)

25283 (DOE/TIC—11205) **Safety Analysis and Review System for coal utilization technology development.** Capps, J.H.; Pearson, J.D. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). 27 May 1980. 29p. NTIS, PC A03/MF A01.

Among the alternative sources and technologies are those being developed by the US Department of Energy's Fossil Energy Program. They include coal liquefaction, coal gasification, fluidized-bed combustion, enhanced oil and gas recovery, underground coal gasification, coalbed methane drainage, oil shale extraction, and others. Developing these technologies requires comprehensive, advanced planning to control safety and health hazards, environmental impacts, and property damage incidents. To control them, the Department of Energy has developed a Safety Analysis and Review System which has been augmented by the DOE Office of Fossil Energy Occupational Safety and Health Manual. These require that, for each technology development project, the associated hazards and their controls be determined and the resultant risks to employees, the public, the environment and property be acceptable before the project is given authorization to proceed. This article describes both the safety analysis techniques being developed to determine the risks, and the report on and independent review of the analysis required before authorization to proceed is given at the Morgantown Energy Technology Center. This center, one of five technology development centers operated by the Office of Fossil Energy of DOE, has responsibilities focusing on coal utilization technology development.

REGULATIONS

REFER ALSO TO CITATION(S) 25237

25284 (CONF-791160—(Vol.2), pp 6p, Paper 4, Session IV) **Development of standards for coal-oil mixtures.** Batra, S.K. (New England Power Service Co., Westborough, MA); Kurtzrock, R.C. 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

As the coal-oil mixture technology nears its commercialization there is a need for uniform performance criteria, testing procedures, and quality control for trouble-free and reliable utilization of this technology. Also, various terminologies associated with this technology need to be defined more precisely to have more meaningful application. With this in view, a Standards and Practice Committee has been formulated to establish criteria for process equipment, instrumentation, characterization of the coal-oil mixtures, and combustion characteristics with respect to industrial and uility application of coal-oil mixtures. Whereas the standards making bodies, such as AISI, ASTM, MSA, ASME and others, will eventually establish the standards, the Standards and Practice Committee will develop guidelines and procedures considering feasibility from the standpoints of both cost and engineering. The paper presents the goals and objectives of this committee with special reference to the various efforts underway in the area of development of standards and procedures.

25285 (CONF-791160—(Vol.2), pp 5p, Paper 1, Session VIII) **Approach to the commercialization of coal/oil mixtures.** Garrett, C.W.; Feibus, H. (Dept. of Energy, Washington, DC). 1979.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

The Office of Coal Resource Management, Resource Applications, US Department of Energy, is charged with the commercialization of technologies that have reached the point in their development cycle where the major barriers to widespread commercial use are other than technical. The commercialization process, from the Government's standpoint, consists of those activities undertaken to promote or accelerate the commercial use of a technology, such as coal-oil mixtures (COM). Several COM initiatives are being contemplated: (1) regional venture analyses, (2) an information outreach program, (3) use of COM in Federal facilities, (4) a technical assistance program, and (5) an examination of selected financial incentives. This paper describes those possible initiatives and invites comments and further ideas.

25286 (DOE/ET/10023—T2) **Terrace pit mining systems, Phase I, Task I.** (TRW Energy Systems Planning Div., McLean, VA (USA)). 7 Dec 1979. Contract AC01-79ET10023. 85p. NTIS, PC A05/MF A01.

This report presents an abstract-index of the agencies, legislation and regulations, in that order, that affect the design and operation of a surface/terrace pit mine on both state and federal levels. It is divided into two sections: The Federal Program and The State Programs. The Federal Program comprises two subsections, the first categorized by the federal administrative agencies and commissions whose jurisdiction encompasses physical mine make-up and worker well being. The second subsection is categorized by environmental performance legislation. This is a cross referenced approach which aids in deciphering the federal program's complex structure. The overlapping authority and duplication of effort that is inherent in federal regulation of a complex industry is illustrated. The State Programs consists of a table of state laws by primary areas of regulation, a summary table of the lead state agencies for the 13 states considered, and an abstract of their designated authority; and finally, a synopsis of the approach used by each state to comply with the environmental performance and occupational safety standards established by the federal government for maintaining air, water and land quality and a safe environment for the worker. The various state agencies which typically have jurisdictional responsibilities for surface mining activities are illustrated. Once the specific terrace pit mining site has been selected, requirements of local government agencies will be identified, analyzed and included in the master list of permit and regulation requirements. The finalized list will be used to

develop the most time effective sequence for submitting permit applications to federal, state and local agencies.

25287 Prospect for anthracite as a national energy resource. Pell, J. *Energy Technol. (Wash., D.C.);* 6: 539-552(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

Federal Energy Administrator John F. O'Leary announced on May 11, 1977 that a Federal Government and industry Anthracite task Force (ATF) would be appointed to recommend policies designed to stimulate demand and increase production of anthracite to meet President Carter's emphasis on coal utilization as outlined in his National Energy Plan. The primary recommendation of the ATF was to establish a separate and distint Anthracite Office within the Department of Energy which could: (1) implement the Task Force recommendations; (2) serve as the focal point in the Administration for anthracite; and (3) provide further analysis of constraints facing anthracite development. Environmental requirements for new anthracite-fired facilities, notably power plants, will be a major determinant of increased anthracite utilization. The most-critical single issue now confronting the potential for revitalization of the anthracite industry is the Environmental Protection Agency's final decision on the New Source Performance Standards for sulfur dioxide removal (the scrubber issue). 22 references.

PETROLEUM

REFER ALSO TO CITATION(S) 25118, 25122

RESERVES

25288 (DOE/EIA—0216(77)) **US crude oil and natural gas reserves. 1977 annual report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Feb 1980. 91p. NTIS, PC A05/MF A01.

Analysis of data filed by 2393 operators of domestic oil and gas wells on Form EIA-23, Annual Survey of Domestic Oil and Gas Reserves, indicates that as of December 31, 1977, the United States proved reserves of crude oil were 31,780 million barrels, excluding lease condensate and other natural gas liquids. Proved reserves of dry natural gas were 207,413 billion cubic feet exclusive of gas contained in underground storage. Comparison of 1977 annual production estimates from this survey, with production data tabulated earlier by the EIA from States sources, indicates virtually no undercoverage of th Form EIA-23 survey frame for crude oil, and minor undercoverage for natural gas. The estimate of combined crude oil and lease condensate production based on the Form EIA-23 survey was 0.1 percent less than indicated by earlier EIA production data, and the estimated natural gas production volume was 1.5 percent less. The estimate of proved reserves of crude oil previously reported by the American Petroleum Institute (API) as of the same date is approximately 7.2 percent lower than the EIA estimate, and the estimate of proved reserves of dry natural gas previously reported by the American Gas Association (AGA) is approximately 1.5 percent lower than the EIA estimate. Ownership data were also collected from the larger operators. These data cover approximately 89 percent of the total estimated proved reserves of dry natural gas and 92 percent of the total estimated proved reserves of crude oil. EIA is verifying, on a continuing basis, the data submitted in response to this survey, by such procedures as auditing some operators' reserves records and by developing independent estimates of proved reserves for a selected sample of fields and reservoirs. These validation activities have led to the conclusion that the operator estimates lie within an acceptable range of variation.

25289 Hybrid approach to the estimation of undiscovered oil resources in the United States. Uri, N.D. (DOE, Washington, DC). *Energy (Oxford);* 4: No. 6, 1079-1085(Dec 1979).

This paper deals with the problem of estimating cumulative reserves and cumulative production of crude oil in the United States. It is first demonstrated that these cumulative values depend on technological change and the price of crude oil. The results suggest that approx. 205 billion barrels of oil are ultimately recoverable and producible at a price of $29 per barrel. Of this total, 114 billion barrels have been produced through the end of 1977. One technique for crude petroleum resource-estimation involves an engineering approach and uses projections of drilling, discovery, and production processes to infer the amount of recoverable oil remaining in the ground. A second technique is an econometric approach and uses a structural model to suggest what future supply can be achieved by producers as they respond to price changes. A combination of these two techniques is the subject of this paper. 11 refs.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 25315

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 25279, 25283, 25296, 25744, 25952

25290 (DOE/BETC/1805—52) **North Stanley Polymer Demonstration Project. Final summary report.** Upton, J.E. (Gulf Oil Exploration and Production Co., Oklahoma City, OK (USA)). May 1980. Contract ET-76-C-03-1805. 47p. NTIS, PC A03/MF A01.

In February 1976, a fresh water preflush was injected into the North Stanley Polymer Demonstration Project, followed by a polymer solution until June 1977 which was chased by a fresh water after flush. A subsequent injection of produced water has been resumed to complete the injection program. Efforts were made to accelerate the change in injection profiles and to decrease per well injection rates by Channelblock treatments and by reducing the injection plant discharge pressures. Total oil production peaked at 660 BPD in January 1977. It slowly declined the remainder of the year to 637 BPD. Subsequent to March 1978, oil production has declined more rapidly and currently the rate of decline is 6.25% per year. As of January 1, 1980, the cumulative production since July 1, 1975 is as follows: (1) gross oil 923,574 barrels; (2) tertiary oil 144,974 barrels; and (3) water produced 57,854,282 barrels.

25291 (DOE/BETC/5785—1) **Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final report.** Doscher, T. (University of Southern California, Los Angeles (USA). Dept. of Petroleum Engineering). May 1980. Contract ET-78-C-05-5785. 501p. Dep. NTIS, PC A22/MF A01.

Individual summaries and pertinent commentaries on each of the groups of references into which the literature on carbon dioxide for the recovery of crude oil has been classified are presented in this report. The major classifications are: physical models, laboratory studies, field tests, modelling, patents, and miscellaneous. A special summary that reviews and comments on field operations, fluid handling, and corrosion problems is also included. User's guide and subject categories for the CO_2 literature survey are given, followed by abstracts of the citations. It is concluded from this survey that the most significant deficiency in research on carbon dioxide flooding for the recovery of crude oil is the paucity of well controlled and interpreted field tests.

25292 (DOE/BETC/RI—80/4) **Technical constraints limiting application of enhanced oil recovery techniques to petroleum production in the United States.** (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Research Center). May 1980. 25p. NTIS, PC A02/MF A01.

A critical examination of the potential and the technical constraint that inhibit the application of enhanced oil recovery techniques in the United States has been initiated and is expected to continue. The examination is based on the results of extensive laboratory and field applications now underway under various forms of Department of Energy support. This interim report will be amplified as data become available and as progress is made toward resolving technical constraints. Comments on the approach and substance of the information contained herein are welcome.

25293 (DOE/BETC/W—26-10) **Chemicals for enhanced oil recovery. Quarterly report, 1 July 1979-30 September 1979.** Compere, A.L.; Crenshaw, J.M.; Greene, S.V. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 45p. NTIS, PC A03/MF A01.

In work on biopolymers, emphasis was on methods of biomass separation from fermentation broth adaptable to field production. A microstrainer is a gravity filter screen mounted on a rotating drum, with feed introduced into the center. A microstrainer pilot unit was tested with the broth from two 300 liter batch fermentations. Screen apertures of 1, 6, and 21μm were evaluated. Biopolymer appeared to pass through the screen in all cases, except for some rejection in a second-stage polishing with a 1μm screen of 21μm effluent. Removal of 80% or more of biomass was attained in most cases. Analysis of results of these runs is continuing, but it appears that microscreens can be useful as an element in biopolymer separation. The filtrate should be much more easily freed of plugging components, even if no suitable alternative to diatomaceous earth filtration is found. Modifications of spinning-drop equipment, particularly temperature control, and procedures have improved consistency of results. With better pH control by substitution of Na_2CO_3-$NaHCO_3$ for part of the NaCl, the preferred alkane for minimum interfacial tension for systems containing sodium-2-ethyl oleate, 0.5 M Na^+, 5% i-butyl alcohol (pH 9.8), and a hydrocarbon was octane, about one carbon number lower than reported last quarter. Results between heptane and decane were consistent with

the triangular inequality rule for interfacial tensions.The increase in fraction of total volume in middle phases caused by substitution of ethoxylated tall oils for part of a petroleum sulfonate surfactant was confirmed. Preliminary conductivity measurements of solutions of sodium p(1-heptylnonyl)benzenesulfonate (Texas No. 1) at 45 C suggest a critical micelle concentration of about 7 x 10^{-4}M.

25294 (DOE/MC/08002—16) **Penn Grade Micellar Displacement Project. Fourth annual report, June 1978-June 1979.** Danielson, H.H.; Paynter, W.T.; Ondrusek, P.S.; Finalle, L.L. (Pennzoil Co., Bradford, PA (USA)). Jun 1980. Contract AC21-76MC08002. 120p. NTIS, PC A06/MF A01.

During fourth year operations of the Penn Grade Micellar Displacement Project, spike polymer injection was completed and body polymer injection was initiated. This report details the operations of Phase II as well as plans for continuing the test.

PROCESSING

REFER ALSO TO CITATION(S) 25181, 25296

25295 (SAN—10760-1) **Hydroprocessing of heavy oils. Quarterly technical progress report, September 4-December 3, 1979.** Bowman, R.M.; Jody, B.J.; Jarvi, G. (Institute of Gas Technology, Chicago, IL (USA)). Feb 1980. Contract AC03-79SF10760. 32p. NTIS, PC A03/MF A01.

Task I experimentation to hydrodesulfurize (HDS) and hydrocrack (HC) No. 4 fuel oil has proceeded. Several commercial hydrotreating catalysts and two proprietary developmental catalysts are on hand. Criteria for judging the performance of these catalysts are twofold: (1) HDS - The fraction of sulfur in the feed oil converted to gas phase compounds, measured by the fraction remaining in the liquid product. (2) HC - The fraction of the liquid oil produced that is characteristic of naphtha, measured by specific gravity, boiling range, and aromatic content. Experiments to date show that the commercial hydrotreating catalysts can meet the HDS criterion, but do not alter the liquid product quality sufficiently for direct steam or autothermal reforming.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 25296, 25297

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25283

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25278, 25279, 25300, 25982, 25996

25296 (DOE/EIA—0115(78)) **Supply, disposition, and stocks of all oils by P.A.D. districts and imports into the United States, by country, final 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 7 Jan 1980. 11p. NTIS, PC A02/MF A01.

Final annual US supply, disposition, and stocks are detailed for: all oils, petroleum products, crude oil, selected natural gas plant liquids, and net unfinished oils for each of five P.A.D. (Petroleum Administration for Defense) Districts for 1978. Petroleum products include motor gasoline, aviation gasoline, jet engine fuels, ethane, liquefied gases, kerosene, distillate fuel oil, residual fuel oil, petrochemical feedstocks, naphthas, lubricants, wax, coke, asphalt, and other products. Also given is the percentage of refinery yields based on crude and net unfinished oil rerun. Imports of petroleum products and of crude oil into the United States are shown by country and continent, with US totals and subtotals for each P.A.D. District. OPEC (Organization of Petroleum Exporting Countries) members are indicated. Data are reported in barrels per day. An accompanying map indicates the US P.A.D. Districts. A brief narrative discusses salient statistics. Prior to the 1978 annual issue, this report was entitled Supply Demand, and Stocks of All Oils by P.A.D. Districts and Imports into the United States, by Country. 1 figure, 6 tables.

25297 (DOE/EIA—0183/16) **Income and price effects on petroleum consumption. An international comparison.** Cato, D.B.; Sandoval, A.D.; Hopkins, F.E. (Department of Energy, Washington, DC (USA). Energy Information Administration). 5 Feb 1980. 76p. NTIS, PC A09/MF A01.

The effects of changes in energy prices and in income on the consumption of oil products are considered for industrial countries: United States, Japan, France, West Germany, Italy, United Kingdom, and various Organization for Economic Cooperation and Development (OECD) country groupings. The major focus is motor gasoline consumption. Relationships between income, prices, and consumption are examined by reviewing estimates of short-run and long-run income and price elasticities from numerous sources. Historical data (1973 to 1977) on consumption, prices, and income are presented to demonstrate how these variables have interacted in the past, and analytical techniques are used to estimate the differential impacts of income and price developments on the level of gasoline consumption during that period. Several bibliographic references are included. 10 figures, 17 tables.

25298 (DOE/IR/10429—1) **Petroleum and natural gas in Illinois.** (Illinois Univ., Chicago (USA). Energy Resources Center). 1979. Contract AP02-80IR10429. 355p. (CONF-7910157—). NTIS, PC A16/MF A01.

From 7. annual Illinois energy conference on petroleum and natural gas in Illinois; Chicago, IL, USA (9 Oct 1979).

Presentations made at the 7th Annual Illinois Energy Conference are compiled and reported. Specific topics include: Illinois petroleum and natural gas supply; energy use patterns for Illinois and the nation; impacts of the National Energy Act on the natural gas industry; natural gas for North America; natural gas supply under the Natural Gas Policy; US access to international oil; deregulation and its impact on the US petroleum supply; the US Energy Policy; petroleum pricing and taxation policies in Illinois; the high cost of energy and its impact on the poor; impact of increased fuel prices on Illinois' industrial future; energy prices and inflation; opportunities for energy conservation in transportaton; overview of energy and synfuels from biomass and wastes; an inventory of energy potential from biomass in Illinois; problems and potential of alcohol from agriculture; liquid and gaseous fuels from coal; and alternatives to liquid and gaseous fuels.

25299 **Annual survey of oil and gas, 1977. Current industrial reports.** Washington, DC; Bureau of Census (1979). 79p. (NP—24444; MA—13K(77)-1).

This release contains final statistics covering oil and gas field exploration, development, and production activities from the 1977 Annual Survey of Oil and Gas. The 1977 survey is the fifth of an annual series conducted by the Bureau of the Census to provide key measures of domestic oil and gas field activity jointly on a net company interest basis and on a gross operator basis. Under the gross operator basis individual companies responsible for the management and day-to-day operation of oil and gas field leases were requested to include data for all properties operated, whether for their own account or for the account of others. Net company interest basis statistics represent the net ownership share of concerns which had operating or nonoperating working interest in oil and gas field leases. The revenues for crude petroleum and condensate and for natural gas on a net company interest basis amounted to 79 percent of gross operator basis revenues. Expenditures for drilling and equipping wells on a net company interest basis were 12 percent less than comparable gross operator figures. The difference between revenues is largely accounted for by nonoperating company interest holders that were not canvassed. Since royalty interest holders in the typical oil and gas field lease agreement do not participate in exploration and development expenditures, the difference between gross operator and net company interest expenditures for drilling and equipping wells can be attributed to nonoperating working interest which were not covered in this survey. Revenues for crude petroleum, condensate, and natural gas on a gross operator basis amounted to $40,960 million in 1977, an increase of 17 percent from the 1976 figure of $35,036 million. The level of 1977 revenues was more than double the 1973 figure of $18,150 million.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25228, 25230, 25283, 26299, 26331, 26348

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 25284, 25285, 25995

25300 (DOE/RG—0030) **Progress report to Congress on the standby motor fuel rationing plans.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Jun 1980. 80p. NTIS, PC A05/MF A01.

This report summarizes the standby gasoline rationing plan; describes the differences between this plan and the one that was transmitted by the President to the Congress on March 1, 1979; and cites some problems inherent in rationing gasoline. The mechanisms contained in the plan for meeting the gasoline needs of end users are

described: the basic allotments for individuals, basic allotments for firms, hardship allotments, and the ration rights market. A discussion of the ration rights market, an analysis of the gains that result from permitting the exchange of coupons, and an estimate of what the price of a coupon would be in a 20% shortfall is included. The economic impacts of the plan are examined: how rationing would affect the average motorist in a 20% shortfall, how the plan would affect households in different income groups, and how rural, suburban and urban households would fare under rationing. An analysis is presented of the alternative of issuing allotments to all licensed drivers and compares this alternative with the allotment mechanism based on motor vehicles. A description of the measures taken to date, since the enactment of the EECA, to develop a gasoline rationing system, and the costs of these measures are provided. A discussion of the measures necessary to bring the system to a satisfactory state of readiness, the estimated costs of these measures, and a timetable for their completion are included. A brief discussion of diesel fuel rationing is also given.

25301 Drilling and operating oil and gas wells in California. Sacramento, CA; California Division of Oil and Gas (1979). 13p. (NP—24446; PR—6S). State of California, Documents Section, North Highlands, CA.

The history of regulatory control for the drilling of oil and natural gas wells in the state of California is related. The role of the Division of Oil and Gas in the supervision of drilling, operation, maintenance, and abandonment of oil and gas wells is defined. Procedures the industry must follow to drill for oil and gas are outlined. (DC)

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 25251, 25252, 25253, 25256

PROPERTIES

REFER ALSO TO CITATION(S) 25207, 25208, 25270

25302 Usefulness of sulfur isotope ratios in crude oil correlations. Gaffney, J.S.; Premuzic, E.T.; Manowitz, B. (Brookhaven National Lab., Upton, NY (USA)). *Geochim. Cosmochim. Acta;* **44**: No. 1, 135-139(Jan 1980).

Sulfur isotope analyses have been completed for twelve samples of marine Jurassic oils from a single basin, and are presented along with previous chemical analyses of the same oils. Two isotopic anomalies are discussed in light of correlational analyses, and show that sulfur isotope ratios, when used with other chemical variables, are sensitive indicators of subtle changes in initial source input. Measurements of delta^{34}S in correlational studies of crude oil characterization and identification are recommended.

COMBUSTION

REFER ALSO TO CITATION(S) 25206, 25260, 25261, 25262, 25263, 25264, 25265, 25266, 25267, 25268, 25270, 25271, 25277

NATURAL GAS

REFER ALSO TO CITATION(S) 25118

RESERVES

REFER ALSO TO CITATION(S) 25288

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 25313, 25822

25303 (DOE/EV—0076) **Environmental data energy technology characterizations: natural gas.** (Mitre Corp., McLean, VA (USA)). Apr 1980. Contract EX-76-C-10-3876. 78p. Dep. NTIS, PC A05/MF A01.

Environmental Data Energy Technology Characterizations are publications which are intended to provide policy analysts and technical analysts with basic environmental data associated with key energy technologies. This publication provides backup documentation on natural gas. The transformation of the energy in gas into a more useful form is described in this document in terms of major activity areas in the gas cycle; that is, in terms of activities which produce either an energy product or a fuel leading to the production of an energy product in a different form. The activities discussed in this document are exploration, extraction, purification, power-plants, storage and transportation of natural gas. These activities represent both well-documented and non-documented activity areas. The former activities are characterized in terms of actual operating data with allowance for future modification where appropriate. Emissions are assumed to conform to environmental standards. The other activity areas examined are those like exploration and extraction, where reliance on engineering studies provided the data. The organization of the chapters in this volume is designed to support the tabular presentation in the summary. Each chapter begins with a brief description of the activity under consideration. The standard characteristics, size, availability, mode of functioning, and place in the fuel cycle are presented. Next, major legislative and/or technological factors influencing the commercial operation of the activity are offered. Discussions of resources consumed, residuals produced, and economics follow. To aid in comparing and linking the different activity areas, data for each area are normalized to 10^{12} Btu of energy output from the activity.

25304 (DOE/METC/5201—5) **Sedimentology, petrology, and gas potential of the Brallier Formation: upper Devonian turbidite facies of the Central and Southern Appalachians.** Lundegard, P.D.; Samuels, N.D.; Pryor, W.A. (Texas Univ., Austin (USA); Amoco Production Co., Houston, TX (USA); Cincinnati Univ., OH (USA). H.N. Fisk Lab. of Sedimentology). Mar 1980. Contract EY-76-C-05-5201. 224p. NTIS, PC A10/MF A01.

The Upper Devonian Brallier Formation of the central and southern Appalachian basin is a regressive sequence of siltstone turbidites interbedded with mudstones, claystones, and shales. It reaches 1000 meters in thickness and overlies basinal mudrocks and underlies deltaic sandstones and mudrocks. Facies and paleocurrent analyses indicate differences between the depositional system of the Brallier Formation and those of modern submarine fans and ancient Alpine flysch-type sequences. The Brallier system is of finer grain size and lower flow intensity. In addition, the stratigraphic transition from turbidites to deltaic sediments is gradual and differs in its facies succession from the deposits of the proximal parts of modern submarine fans. Such features as massive and pebbly sandstones, conglomerates, debris flows, and massive slump structures are absent from this transition. Paleocurrents are uniformly to the west at right angles to basin isopach, which is atypical of ancient turbidite systems. This suggests that turbidity currents had multiple point sources. The petrography and paleocurrents of the Brallier Formation indicate an eastern source of sedimentary and low-grade metasedimentary rocks with modern relief and rainfall. The depositional system of the Brallier Formation is interpreted as a series of small ephemeral turbidite lobes of low flow intensity which coalesced in time to produce a laterally extensive wedge. The lobes were fed by deltas rather than submarine canyons or upper fan channel systems. This study shows that the present-day turbidite facies model, based mainly on modern submarine fans and ancient Alpine flysch-type sequences, does not adequately describe prodeltaic turbidite systems such as the Brallier Formation. Thickly bedded siltstone bundles are common features of the Brallier Formation and are probably its best gas reservoir facies, especially when fracture porosity is well developed.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 25279, 25303, 25305

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25279, 25298, 25299, 25982

25305 (DOE/EIA—0129/78) **Main line natural gas sales to industrial users: 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 8 Jan 1980. 73p. NTIS, PC A04/MF A01.

Main line natural gas sales (in million cubic feet) by interstate natural gas companies to industrial users are itemized for 1974 to 1978. Information includes company name, customer name, customer's Standard Industrial Classification (SIC), the type of sale (where available and applicable), the delivery point, and the state involved in transactions. Tabulations summarize sales by SIC, by state and SIC, and by natural gas companies and SIC. Also summarized in the tables are sales by state and type (offpeak, interruptible, and not specified) for 1978. A brief narrative highlights recent trends and makes comparisons between the two most recent years. 5 tables.

25306 (GRI—78/0012) **Flared gas conservation. Final report for 1979.** Gammell, D.M.; Williams, J.H.; Krueger, S. (Brown (Robert) Associates, Carson, CA (USA)). Jul 1979. Contract EX-77-C-02-4505. 39p. NTIS, PC A03/MF A01.

This study concludes that those natural gases which are currently being vented or flared in quantities which could approach some economically feasible method of recovery are of a temporary or intermittent (upset) nature. In oil producing states, no flare laws are in effect and field flaring or venting quantities must be recorded and explained. Major oil refiners fall under similar constraints. At least three major refiners in the nation now sell or anticipate selling surplus off-gas production. Conservation efforts now being utilized include reinjection of the natural gases back to the oil well, and some expansion of existing gas gathering systems. Nine possible gas recovery methods were evaluated which might be practical: centralized gas plant, fuel cell, gas engine generators or gas turbine generators, carbon black (centralized), ammonia (centralized), cogeneration, LNG (centralized), and compressed gas. Of the nine gas recovery methods economically evaluated for a hypothetical large West Texas oil field, fuel cells appear relatively attractive for the near future (1983 to 1985). In general, the value of purchased electrical power needs to increase less than two-fold to make fuel cell power competitive. Natural gas values need to increase two- to five-fold to justify gas recoveries under conventional methods.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 25228, 25229, 25230

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 25829

25307 (DOE/BC/10003—6) **Western Gas Sands Project status report, 1 February-29 February 1980.** (CER Corp., Las Vegas, NV (USA)). 1980. Contract AC08-79BC10003. 65p. NTIS, PC A04/MF A01.

This edition of the WGSP Status Report summarizes the progress during February 1980, of the government-sponsored projects directed toward increasing gas production from low-permeability gas sands of the western United States. The National Laboratories and Energy Technology Centers continued research and experiments toward enhanced gas recovery. The field test and demonstration program continued with various projects, including test data collection by the DOE Well Test Facility at CIG's Miller No. 1 site.

25308 (DOE/ET/27098—1) **Computer simulation of production from geopressured-geothermal aquifers. Project 61025 annual report, October 1, 1978-September 30, 1979.** Rogers, L.A. (Institute of Gas Technology, Chicago, IL (USA)). Jun 1980. Contract AC08-78ET27098. 102p. NTIS, PC A06/MF A01.

In the Department of Energy test of the Edna Delcambre No. 1 well for recovery of natural gas from geopressured-geothermal brine, part of the test producted gas in excess of the amount that could be dissolved in the brine. Where this excess gas originated was unknown and several theories were proposed to explain the source. This annual report describes IGT's work to match the observed gas/water production with computer simulation. Two different theoretical models were calculated in detail using available reservoir simulators. One model considered the excess gas to be dispersed as small bubbles in pores. The other model considered the excess gas as a nearby free gas cap above the aquifer. Reservoir engineering analysis of the flow test data was used to determine the basic reservoir characteristics. The computer studies revealed that the dispersed gas model gave characteristically the wrong shape for plots of gas/water ratio, and no reasonable match of the calculated values could be made to the experimental results. The free gas cap model gave characteristically better shapes to the gas/water ratio plots if the initial edge of the free gas was only about 400 feet from the well. Because there were two other wells at approximately this distance (Delcambre No. 4 and No. 4A wells) which had a history of downhole blowouts and mechanical problems, it appears that the source of the excess free gas is from a separate horizon which connected to the Delcambre No. 1 sand via these nearby wells. This conclusion is corroborated by the changes in gas composition when the excess gas occurs and the geological studies which indicate the nearest free gas cap to be several thousand feet away. The occurrence of this excess free gas can thus be explained by known reservoir characteristics, and no new model for gas entrapment or production is needed.

25309 (DOE/MC/11577—T4) **Small-scale experiments with an analysis to evaluate the effect of tailored pulse loading on fracture and permeability. Quarterly report 2, December 11, 1979 through March 11, 1980.** McHugh, S.L.; DeCarli, P.S.; Keough, D.D. (SRI International, Menlo Park, CA (USA)). Apr 1980. Contract AC21-79MC11577. 91p. NTIS, PC A05/MF A01.

Because of the potential for increased gas production in the eastern Devonian shales, these materials were selected for the evaluation of well stimulation techniques. One technique selected for further study was blasing with tailored pulse loading, i.e., shaping the borehole input pressure-history to produce a specified fracture pattern. A two-year program was initiated to examine the effects on fracture of pulse tailoring. In Task 1, field experiments are being performed at the Nevada Test Site (NTS) to evaluate computational fracture predictions and to evaluate various well shooting concepts. Task 2 consists of laboratory measurements and springing experiments to determine site material properties and NAG-FRAG fracture parameters (in the SRI microstructural model). Task 3 is a theoretical and computational effort. During this quarter, a shear cracking model and a model for gas penetration effects were incorporated into NAG-FRAG, and simulations of the laboratory springing experiments were performed.

25310 (DOE/METC/SP—80/12) **Semi-annual report for the unconventional gas recovery program, period ending March 31, 1980.** Manilla, R.D. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Jun 1980. 501p. NTIS, PC A22/MF A01.

Four subprograms are reported on: methane recovery from coalbeds, Eastern gas shales, Western gas sands, and methane from geopressured aquifers. (DLC)

25311 (SAND—79-2072) **Improved fracturing second quarterly report, July 1979-September 1979.** Schuster, C.L. (ed.). (Gas Research Inst., Chicago, IL (USA)). Oct 1979. Contract EY-76-C-04-0789. 17p. Dep. NTIS, PC A02/MF A01.

This is the second quarterly report of the activities by Sandia Laboratories for Gas Research Institute. Technical discussions were continuing to be conducted with G.R.I., Columbia Gas, Mitchell Energy and Weed-Henry regarding fracture diagnostic experiments in the Eastern Devonian Shale. The second Project Advisors' meeting was also held in Las Vegas, Nevada in conjunction with a tour of the Nevada Test Site.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 25301, 25991, 25995

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 25303, 25312, 26089

STORAGE

25312 (DOE/EIA—0151/78) **Underground storage of natural gas by interstate pipeline companies for 1978 and winter 1978-1979. Energy data report.** Pappas, T.A. (Department of Energy, Washington, DC (USA). Energy Information Administration). 22 Jan 1980. 39p. NTIS, PC A03/MF A01.

Underground storage of natural gas by pipeline companies subject to the jurisdiction of the Federal Regulatory Commission (FERC) are given for the most recent calendar year and of the most recent winter heating season. Annual data are based on FERC Form 2, annual reports of 32 companies, and winter data are from FERC Form 8, semi-monthly reports of 32 pipeline companies and 5 independent producers. Covered for the two most recent years are the underground gas storage, deliverability, and peak day use for pipeline companies; the estimated cost of storing gas underground; comparisons of fixed cost with operating and maintenance expenses for storing gas, and of the capacity used and the cost of storing gas; and gas injections and withdrawals. Data for the most recent winter heating season (November through March) include gas storage balance; the natural gas in underground storage (injections and withdrawals), in reservoirs, and in storage owned by reporting companies; comparisons of total gas withdrawn from storage, and of net withdrawals from storage. Data are shown by company and by geographic region (Eastern, Midwestern, Southern, and Western). Gas data are reported in thousand cubic feet, with some percentage comparisons. The preface and the narratives at the beginning of each of the four sub-sections explain methodologies and definitions, and highlight statistics. 10 figures, 12 tables.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 25118, 25122

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

25313 (DOE/METC/5199—7) **Inorganic geochemistry of Devonian shales in southern West Virginia: geographic and stratigraphic trends.** Hohn, M.E.; Neal, D.W.; Renton, J.J. (West Virginia Geological and Economic Survey, Morgantown (USA)). Apr 1980. Contract EY-76-C-05-5199. 41p. NTIS, PC A03/MF A01.

Samples of cuttings from twenty-one wells and a core from a single well in southern West Virginia were analyzed for major and minor elements: silicon, aluminum, iron, magnesium, calcium, sodium, titanium, phosphorus, manganese, sulfur, zinc, and strontium. Stratigraphic and geographic controls on elemental abundances were studied through canonical correlations, factor analyses, and trend surface analyses. The most abundant elements, silicon and aluminum, show gradual trends through the stratigraphic column of most wells, with silicon increasing and aluminum decreasing upsection. Other elements such as calcium, sulfur, and titanium change abruptly in abundance at certain stratigraphic boundaries. Important geographic trends run east-west: for instance, one can see an increase in sulfur and a decrease in titanium to the west; and a decrease in silicon from the east to the central part of the study area, then an increase further west. Although observed vertical trends in detrital minerals and geographic patterns in elemental abundances agree with the accepted view of a prograding delta complex during Late Devonian time, geographically-local, time restricted depositional processes influenced elemental percentages in subsets of the wells and the stratigraphic intervals studied. The black shales of lower Huron age do not represent simply a return of depositional conditions present in the earlier Rhinestreet time; nor do the gray shales of the Ohio Shale represent the same environmental conditions as the Big White Slate.

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 26737

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 25997

25314 (DOE/LETC/RI—80/9) **Oil shale oxidation at subretorting temperatures.** Jacobson, I.A. Jr. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Jun 1980. 44p. NTIS, PC A03/MF A01.

Green River oil shale was air oxidized at subretorting temperatures. Off gases consisting of nitrogen, oxygen, carbon monoxide, carbon dioxide, and water were monitored and quantitatively determined. A mathematical model of the oxidation reactions based on a shrinking core model has been developed. This model incorporates the chemical reaction of oxygen and the organic material in the oil shale as well as the diffusivity of the oxygen into the shale particle. Diffusivity appears to be rate limiting for the oxidation. Arrhenius type equations, which include a term for oil shale grade, have been derived for both the chemical reaction and the diffusivity.

25315 **Unconventional petroleum resources in California.** Hallmark, F.O. Sacramento, CA; California Division of Oil and Gas (1980). 17p. (NP—24445; TR—25).

Unconventional petroleum deposits found in California are discussed. The presence of diatomaceous oil shales and methods of recovery are described. Locations of these deposits are given. Ultraheavy oil and tar sands are also discussed. The locations of tar sand fields are given. The need for identifying and quantifying the potential of these petroleum resources is presented. (DC)

IN SITU METHODS, TRUE AND MODIFIED

25316 (DOE/LETC/10787—43) **Geokinetics in situ shale oil recovery project. Third annual report, 1979.** Hutchinson, D.L. (Geokinetics, Inc., Concord, CA (USA)). May 1980. Contract FC20-78LC10787. 49p. NTIS, PC A03/MF A01.

Objective is to develop a true in situ process for recovering shale oil using a fire front moving in a horizontal direction. The project is being conductd at a field site located 70 miles south of Vernal, Utah. During 1979, five retorts were blasted. Four of these were small retorts (~ 7000 tons), designed to collect data for improving the blast method. The fifth retort was a prototype of a full-sized retort measuring approximately 200 ft on each side. Two retorts, blasted the previous year, were burned, and a third retort was ignited near the end of the year. A total of 5170 bbl of oil was produced during the year.

25317 (LBL—10431) **Hydraulic calculations for a modified in-situ retort.** Hall, W.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 19p. NTIS, PC A02/MF A01.

This report contains brief descriptions of a numerical model and the aquifer-retort system used to investigate hydraulics in the vicinity of a modified in-situ retort. The model is used to analyze several cases involving different physical and geohydrological parameters, and possible applications of the model to in-situ oil shale recovery are discussed.

25318 (LETC—10787-39) **Investigation of the geokinetics horizontal in situ oil shale retorting process. Quarterly report, October-December 1979.** Hutchinson, D.L. (Geokinetics, Inc., Concord, CA (USA)). Feb 1980. Contract ET-78-F-03-1787. 40p. Dep. NTIS, PC A03/MF A01.

The burn of Retort 17 was terminated December 10. Retort 18 was ignited November 12. Retort 17 produced 510 bbl during the quarter for the total of 3,775 bbl, while Retort 18 produced 1,187 bbl. The shale oil was analyzed. Environmental studies were done.

25319 (SAND—80-0468) **FY 80 Tar Sands Program first quarterly report, January 1980.** Fox, R.L.; Wayland, J.R. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 18p. NTIS, PC A02/MF A01.

Research and development efforts in support of the Tar Sands program well completions and stimulation subactivity and new and novel concepts task have been initiated. The objectives of the well completion and stimulation efforts are to carry out research and development in areas with significant for long-range tar sand extraction development as well as provide potential interaction and support of the near-term tar sand field experiments. Evaluation testing of packers and computational analysis of well bore insulation for tar sands steam recovery injection wells have been investigated this quarter. Production well completions for the tar sand steam drive experiment have been examined, and a program to measure downhole steam quality in the experiment is under development. Initial examination of the application of the DOE downhole steam generator program to tar sand reservoirs has commenced. The examination of new and novel concepts for extraction of tar sands has been initiated. An overburden replacement technique was evaluated both computationally and in a laboratory scale experiment. Analyses of both microwave heating and in situ hydrogenation are being initiated.

25320 (SAND—80-0564) **Instrumentation and operational plan for geokinetics retort No. 22.** Parrish, R.L.; Hommert, P.J. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 34p. NTIS, PC A03/MF A01.

This report outlines the general plan for the instrumentation and technical direction of a horizontal in siti retorting experiment to be conducted at the Geokinetics, Inc. field site in Uintah County, Utah. Bed preparation has been accomplished by Geokinetics by blasting the retort zone with explosives emplaced in wells drilled from the surface. Downhole instrumentation will consist of ~ 300 thermocouples and 28 combustion gas sampling ports to monitor the movement of the reaction front during the retorting process. Surface instrumentation will provide measurements of flow rates, gas composition, liquid products and other process parameters to monitor the overall operation of the process. The operational plan includes provision for data interpretation and real time material balance calculations in the field, including an evaluation of the effect on processing rates and oil yield due to the use of recycled combusted off gases and changes in rate of injection of inlet gases.

25321 (UCID—18556) **Underground oil shale retorting.** Campbell, J.H.; Raley, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1980. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

The basic principles involved in combustion processing of oil shale are outlined. The manual is designed to serve as an introduction to the subject for the support personnel of the LLL Oil Shale Project. The material is presented in a simple two page format with one page devoted to a figure or table and the facing page contains a brief description of that material. Thus, it can serve as a self-study guide. Following a brief description of oil shale, how it was formed, and the extent of the resource, an overview of the concepts and major technical problems of Modified In-Situ (MIS) Oil Shale Retorting is presented. Finally, the liquid product, shale oil, is compared with typical petroleum crudes.

25322 **Numerical modeling of a true in situ oil shale retort.** Tyner, C.E.; Hommert, P.J. (Sandia Lab, Albuquerque, NM). *Energy Commun.;* **5**: No. 6, 373-403(1979).

A numerical model has been developed to simulate the true in situ retorting process. The retort is assumed to be a low-porosity fractured bed composed of large seams of competent shale separated at intervals by open fractures. Kerogen and carbonate decomposition and char, oil, and gas combustion, as well as other reactions, are considered. In contrast to the results of rubbled-bed models, the retorting of seams thicker than one meter is characterized by incomplete retorting and significant oil combustion (10 to 40% of that retorted). The amount of shale retorted can, however, be maximized by proper control of air and steam injection rates, with the injected gas being optimally 40 to 50% steam. The oil available for recovery from a two meter seam can then be, for example, as high as 50% of Fischer Assay. 13 refs.

25323 **Transport processes in pyrolysis of Antrim oil shale.** Crowl, D.A.; Piccirelli, R.A. (Wayne State Univ, Detroit, Mich). *Energy Commun.;* **5**: No. 6, 425-470(1979).

The pyrolysis of spheres and slabs of consolidated Antrim oil shale is analyzed and modeled. The primary emphasis is on determining the manner in which the transport processes control the yield of pyrolysis product. The model parameters are chosen so as to reflect the conditions expected during In Situ retorting. Also, although complex kinetics is expected to strongly influence the yield, only a single reaction is used to describe the generation of gaseous pyrolysis product. Numerical solution of the equations shows that over a wide range of conditions, the pressure and velocity profiles within the shale due to generation of gaseous reaction products can be assumed to be a quasi-steady state. It is also shown that, the unreacted, shrinking core model is inadequate for describing shale pyrolysis. 28 refs.

SURFACE METHODS

25324 (FE—14102-1) **Synthetic fuels from US oil shales: a technical and economic verification of the HYTORT Process. Quarterly report, October 1-December 31, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). Feb 1980. Contract AC01-79ET14102. 30p. NTIS, PC A03/MF A01.

Reported are: laboratory program (thermobalance tests of shales, calorimetric studies), bench-scale program (reactor tests, hydrogen production, shale oil upgrading), process development unit tests, environmental assessment, and process design/economics. (DLC)

25325 (UCRL—84142) **Solar retorting of oil shale.** Gregg, D.W.; Grens, J.Z.; Taylor, R.W.; Aiman, W.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Apr 1980. Contract W-7405-ENG-48. 37p. (CONF-800610—6). NTIS, PC A03/MF A01.

From American Institute of Chemical Engineering conference; Philadelphia, PA, USA (8 Jun 1980).

A detailed analysis of technical and economic factors solar retorting of oil shale shows that such a process should be technically feasible and, depending on the grade of the shale, should improve the fuel yield from the oil shale by 10 to 40%, compared to one of the best competing surface ay for the incremental processes. The improved oil yield should more than pay for the incremental cost associated with adding the solar collection system. An experiment is described in which solar energy is used to retort oil shale, and the experimental results show that yields of better than 110% Fischer Assay are achievable. An advanced design for a solar oil-shale retort is also discussed.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 25318, 26179

25326 (FE—2346-61) **Origin of the quartz in Antrim Shale.** Hathon, C.; Sibley, D.; Cambray, F.W. (Dow Chemical Co., Midland, MI (USA)). 15 Feb 1980. Contract EX-76-C-01-2346. 36p. NTIS, PC A03/MF A01.

Study of the macroscopic and microscopic properties of the Antrim Shale indicated an important anomaly, the quartz. The Antrim Shale (Devonian, Michigan Basin) contains a large, but quantitatively undertermineable volume of authigenic quartz. The shale contains approximately 50% quartz by weight of which, in the >500 mesh size fraction, 56% is polycrystalline. This is approximately 2X the amount of quartz in most shales and 10X the amount of polycrystalline quartz in the silt-size fraction of sandstones and shales. Scanning electron microscopy reveals an authigenic surface composed of hexagonal tabular plates which coalesce to form smooth grain surfaces. These plates have not been previously reported on quartz grains. Oxygen isotopes of quartz and carbonate phases are interpreted to indicate a gradual isotopic lightening of the pore fluids, from approximately -4‰. Most of the authigenic quartz has a $\delta^{18}O = 22‰$ (SMOW).

25327 (LETC/RI—80/5) **Fluid flow through racked columns of crushed oil shale.** Minster, R.A.; Fausett, D.W. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Apr 1980. 38p. NTIS, PC A03/MF A01.

This report presents the results of an engineering analysis of the pressure drop occurring when a fluid is passed through a packed column of crushed, raw oil shale. An equation of the Ergun type was found to give a good fit to pressure drop data generated by an experimental program. The experimental apparatus and procedure are described. The method of analysis is discussed, and an example of its application is included.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 25225

25328 (DOE/LETC/RI—80/8) **Thermal behavior of dawsonite.** Keenan, F.J.; Howatson, J.; Smith, J.W. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Jun 1980. 18p. NTIS, PC A02/MF A01.

Evidence for the dawsonite decomposition reaction sequence is presented. Synthetic dawsonite was heated at temperatures from 250 to 800°C and studied by X-ray powder diffraction and infrared spectroscopy. From 350 to 550°C sodium carbonate and a low temperature form of alumina were the main products. Hydrolysis experiments showed that this heretofore unidentified alumina product is rho-alumina. At temperatures of 600°C and above, the sodium carbonate and rho-alumina react in an incomplete solid state reaction to form crystalline sodium aluminate.

25329 (DOE/LETC/RI—80/8) **Thermal behavior of dawsonite.** Keenan, F.J.; Howatson, J.; Smith, J.W. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Jun 1980. 18p. NTIS, PC A02/MF A01.

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HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25283, 26439

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25283

25330 (DOE/EV/4018—4) **Reclamation studies on oil shale lands in northwestern Colorado.** Cook, C.W.; Redente, E.F. (Colorado State Univ., Fort Collins (USA). Dept. of Range Science). Feb 1980. Contract EY-76-S-02-4018. 64p. NTIS, PC A04/MF A01.

The overall objective of this project is to study the effects of various reclamation practices on above- and belowground ecosystem development associated with disturbed oil shale lands in northwestern Colorado. Plant growth media that are being used in field test plots include retorted shale, soil over retorted shale, subsoil materials, and surface disturbed topsoils. Some of the more significant results are: (1) a soil cover of at least 61 cm in conjunction with a capiallary barrier provided the best combination of treatments for the establishment of vegetation and a functional microbial community, (2) aboveground production values for native and introduced species mixtures are comparable after three growing seasons, (3) cover values for native species mixtures are generally greater than for introduced species, (4) native seed mixtures, in general, allow greater invasion to occur, (5) sewage sludge at relatively low rates appears to provide the most beneficial overall effect on plant growth, (6) cultural practices, such as irrigated and mulching have significant effects on both above- and belowground ecosystem development, (7) topsoil storage after 1.5 years does not appear to significantly affect general microbial activities but does reduce the mycorrhizal infection potential of the soil at shallow depths, (8) populations of mycorrhizal fungi are decreased on severely disturbed soils if a cover of vegetation is not established, (9) significant biological differences among ecotypes of important shrub species

have been identified, (10) a vegetation model is outlined which upon completion will enable the reclamation specialist to predict the plant species combinations best adapted to specific reclamation sites, and (11) synthetic strains of two important grass species are close to development which will provide superior plant materials for reclamation in the West.

25331 (DOE/LC/10036—T4(Vol.2)) **Occidental vertical modified in situ process for the recovery of oil from oil shale, phase I. Final report, November 1, 1976-April 30, 1979.** Loucks, R.A. (Occidental Oil Shale, Inc., Grand Junction, CO (USA)). Nov 1979. Contract FC20-78LC10036. 630p. NTIS, PC A99/MF A01.

This report presents analyses in all of the broad environmental areas identified in the Development Monitoring Program for data collected since November 1976. Because there is always a data-lag and reduction problem, analyses for some studies are based on data only through September 1978. The Interim Monitoring and Development Monitoring Programs have been reduced and changed from the Environmental Baseline Monitoring Program in many areas. Therefore, emphasis is now placed on key indicators of environmental quality and/or change which are evaluated in this report. The purpose of this report is to fulfill the requirement of the lease to provide the Area Oil Shale Supervisor's Office with an annual report of environmental analyses. Environmental monitoring and analyses are continuing on Oil Shale Tract C-b. Development activities commenced within the past year have resulted in increased activity on the Tract in the form of off-road vehicular use, facility construction, shaft sinking, and traffic into and out of the area. All activity has been conducted within strict adherence to environmental, permit, and lease regulations. Environmental impacts, where they exist, have been confined to the immediate area and within limits defined in the Detailed Development Plan.

25332 (SAN—1747-T2) **Geology and geohydrology elements of the environmental research plan, BX In Situ Oil Shale Project, Rio Blanco County, Colorado.** Loo, W.W.; Markley, D.E. (VTN Consolidated, Inc., Irvine, CA (USA)). 1 Nov 1979. Contract ET-78-F-03-1747. 147p. NTIS, PC A07/MF A01.

This report was prepared as a part of the overall environmental research plan for the BX In Situ Oil Shale Project. The BX In Situ Oil Shale Project is located in the central portion of the Piceance Creek Basin of northwestern Colorado. Within this basin is a section of oil shale bearing rocks in the Parachute Creek member of the Green River Formation commonly referred to as the leached zone which contains very large reserves of oil in place as oil shale. This section of leached zone has enough prmeability and porosity to permit in situ retorting of the oil shale contained therein without resorting to mining and/or other fracturing techniques. The purpose of the BX In Situ Oil Shale Project is to demonstrate the technical feasibility of using superheated steam at 1000°F and 1500 psig as a heat carrying medium to retort oil shale in the leched zone in situ and to provide a mechanism for the recovery of this oil with minimum impact on the environment. More specifically, the oil shale will be retorted by injecting superheated steam into the leached zone through an array of injection wells and recovering the steam/water/oil and gas produced from the leached zone through an array of production wells. The environmental research plan is designed to determine the surface and subsurface effects of project operations in order to allow estimates of the environmental impacts of commercial oil shale development. To allow determination of project impacts, basic geologic and geohydrologic conditions were determined.

NUCLEAR FUELS

RESERVES

25333 (GJBX—11(80)) **National uranium resource evaluation, NURE 1979: annual activity report.** (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Mar 1980. Contract AC13-76GJ01664. 105p. NTIS, PC A06/MF A01.

NURE is a DOE-directed program with the major goal of establishing reliable and timely comprehensive estimates of the uranium resources of the nation. To develop and compile geologic, geophysical, and other information which will contribute to assessing the distribution and magnitude of uranium resources and to determine areas favorable for the occurrence of uranium in the United States, NURE has been organized into the following elements: (1) quadrangle evaluation; (2) aerial radiometric reconnaissance; (3) subsurface investigations; (4) hydrogeochemical and stream-sediment reconnaissance; (5) geologic studies; (6) technology applications; and (7) information dissemination. The extensive effort now under way on each of these NURE program elements will result in a systematic collection and compilation of data which will be culminating in a comprehensive report covering certain priority areas of the United States. This report summarizes the technical activities undertaken during 1979 to support this program.

25334 (GJBX—38(80)) **National Uranium-Resource Evaluation: genesis of the Bokan Mountain, Alaska uranium-thorium deposits.** Thompson, T.B.; Lyttle, T.; Pierson, J.R. (Colorado State Univ., Fort Collins (USA). Dept. of Earth Resources). Jan 1980. Contract EY-76-C-13-1664. 239p. NTIS, PC A11/MF A01.

The objective of this research project is to develop a model that can be used in evaluating peralkaline granitic-syenitic rocks for uranium potential. The deposits at Bokan Mountain (also known as Kendrick Bay) were studied to generate a specific model as to their mode of formation. To achieve the objective several types of data have been obtained: (1) Distinction by mapping and core logging of multiple intrusive phases within the Bokan Mountain Granite complex; (2) Detailed chemical and petrographic data on each igneous phase; (3) Extent of and mineralogical/chemical characteristics of the associated wallrock alteration; (4) Radiometric dates on magmatic and hydrothermal products; (5) Fluid inclusion analysis of quartz, calcite, and fluorite from mineralized rock; (6) Ore and sulfide mineralogy; (7) C, O, and S isotope analyses of minerals from mineralized rock; (8) Trace element dispersion with respect to mineralized zones; and (9) Structural data for interpretation of emplacement mechanisms as well as post-magmatic events important to ore localization. The U/Th mineralization is localized in shear zones as vein-like bodies or in irregular cylindrical bodies formed by concentrations of microfractures. The ore zones are localized within or on top of syenitic masses and have intense albitization and chloritization, with subordinate amounts of calcite, fluorite, quartz, sulfides, and tourmaline. Hematite occurs peripherally to the higher-grade ore zones. Uranothrorite and uraninite are the main ore minerals.

25335 (GJBX—61(80)) **Uranium distribution in relation to sedimentary facies, Kern Lake, California.** Merifield, P.M.; Carlisle, D.; Idiz, E.; Anderhalt, R.; Reed, W.E.; Lamar, D.L. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Apr 1980. Contract EY-76-C-13-1664. 71p. NTIS, PC $6.50/MF $3.50.

Kern Lake has served as a sink for drainage from the southern Sierra Nevada and, in lesser amounts, from the southern Temblor Range. Both areas contain significant uranium source rocks. The uranium content in Holocene Kern Lake sediments correlates best with the mud (silt and clay) fraction. It correlates less well with organic carbon. Biotite grains could account for much of the uranium in the sand fraction, and perhaps the silt fraction as well. The data suggest that fixation of uranium by adsorption on mineral grains is a dominant process in this lake system. Further work is required to determine the importance of cation-exchange of uranium on clays and micas and of organically complexed uranium adsorbed to mineral surfaces. These findings also raise the question of whether uranium transport down the Kern River occurs largely as uranium adsorbed to mineral surfaces.

EXPLORATION

REFER ALSO TO CITATION(S) 25362

25336 (GJBX—26(80)) **Geometric pattern recognition techniques applied to land Landsat digital data for uranium exploration.** (Earth Satellite Corp., Washington, DC (USA)). 1979. Contract AC13-76GJ01664. 291p. NTIS, PC A13/MF A01.

Although the results we obtained cannot be described as providing a new tool for uranium exploration, we saw clear evidence that computed texture measures are describing some element of the Landsat data source that cannot be readily observed or analyzed by human interpreters. The success of Eigenband 3 is less surprising, since we had other evidence suggesting that such a band ought to be relevant to image textures.

25337 (GJBX—86(80)) **Engineering report on drilling in the western Prescott and Williams Quadrangles, Arizona.** McCaslin, J.L. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Apr 1980. Contract EY-76-C-13-1664. 68p. NTIS, PC $7.50/MF $3.65.

This report presents engineering details, statistics, and individual borehole histories of the 18 holes drilled for this project. Charts showing daily drilling progress are included in Appendix A, and geophysical logs, on microfiche, are included. This project consisted of 18 drill holes ranging in depth from 1,341 ft (408.7m) to 5,491 ft (1,673.7m). A total of 63,520 feet (19,360.9m) was drilled during the project. The objective of the project was to obtain subsurface data that would permit a more accurate estimate to be made of the uranium potential in the Tertiary basins within the project area. This project began on June 22, 1979. All drilling was completed on October 30, 1979, and final site restoration continued through November and December.

25338 (GJBX—90(80)(Vol.2-A)) **NURE aerial gamma-ray and magnetic detail survey: Reading Prong area. Volume II-A. Maps.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1980. Contract EY-76-C-13-1664. 548p. NTIS, PC A23/MF A01.

Volume II-A contains the following maps from the aerial gamma-ray and magnetic detail survey of the Reading Prong area of Pennsylvania: flight line base, magnetic contour, uranium, thorium, potassium, uranium/thorium, thorium/potassium, uranium/potassium, multi-variate analysis, and geochemical analysis.

25339 (GJBX—90(80)(Vol.2-B)) **NURE aerial gamma-ray and magnetic detail survey: Reading Prong area. Volume II-B. Radiometric multiple-parameter stacked profiles.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1980. Contract EY-76-C-13-1664. 608p. NTIS, PC A99/MF A01.

The radiometric multiple-parameter stacked profiles obtained from the aerial gamma-ray and magnetic detail survey over the Reading Prong area of Pennsylvania are presented.

25340 (GJBX—90(80)(Vol.2-C)) **NURE aerial gamma-ray and magnetic detail survey: Reading Prong area. Volume II-C. Radiometric multiple-parameter stacked profiles.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1980. Contract EY-76-C-13-1664. 664p. NTIS, PC A99/MF A01.

Radiometric multiple-parameter stacked profiles obtained from the aerial gamma-ray and magnetic detail survey over the Reading Prong area of Pennsylvania are presented.

25341 (GJBX—90(80)(Vol.2-D)) **NURE aerial gamma-ray and magnetic detail survey: Reading Prong area. Volume II-D. Magnetic and ancillary stacked profile data.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1980. Contract EY-76-C-13-1664. 616p. NTIS, PC A99/MF A01.

Magnetic and ancillary stacked profile data obtained from the aerial gamma-ray and magnetic detail survey over the Reading Prong area of Pennsylvania are presented.

25342 (GJBX—90(80)(Vol.2-E)) **NURE aerial gamma-ray and magnetic detail survey: Reading Prong area. Volume II-E. Magnetic and ancillary stacked profile data.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Jan 1980. Contract EY-76-C-13-1664. 801p. NTIS, PC A99/MF A01.

Magnetic and ancillary stacked profile data obtained from the aerial gamma-ray and magnetic detail survey over the Reading Prong area of Pennsylvania are presented.

25343 (GJBX—110(80)) **National Uranium Resource Evaluation: literature survey on radon distributions in soil and air. Final report.** Rubin, R.M. (Radiation Research Associates, Inc., Fort Worth, TX (USA)). Sep 1978. Contract EY-76-C-13-1664. 72p. (RRA-T—7808). NTIS, PC A04/MF A01.

Aerial survey techniques for locating uranium-ore deposits measure the gamma rays emitted by ^{214}Bi and ^{210}Pb, daughters of the ^{238}U chain. Measured gamma-ray activity must be corrected to yield the contribution from ground activity. At present, the separation of background (radon daughter activity, cosmic rays, etc.) from the ground contribution is not performed adequately. As part of the effort to develop a better method of removing airborne radon daughter gamma-ray contributions from the total, a survey of available information on the emanation rate of ^{222}Rn from the ground and the vertical distribution of ^{222}Rn in the air was undertaken. Approximately 141 references were consulted. Of these, thirty-nine were related to ground emanation data, and sixty were related to vertical distributions. The remainder were either related to detection of radon or only indirectly related. A complete list of the literature consulted is given in Section V. The literature tends to confirm the values of input quantities and output vertical distributions used by Lampley and Wells. Emanation rates from non uranium ore bearing soil are of the order of .037 Bq/m^2 sec (1.pCi/m^2sec). Vertical distribution of radon tends to vary slowly and exponentially with altitude. Ground level values of the radon concentration are of the order of 4 Bq/m^3 (100 pCi/m^3).

25344 (GJBX—111(80)) **Application of lidar to measurement of airborne radon and its daughter products.** Brown, D.M.; Wells, M.B. (Radiation Research Associates, Inc., Fort Worth, TX (USA)). Jan 1980. Contract EY-76-C-13-1664. 194p. (RRA-T—8001). NTIS, PC A09/MF A01.

A literature review was undertaken to survey the data available on atmospheric aerosols and the attachment of airborne radon daughters to aerosols. A study was made to determine the possibility of using an airborne lidar system on uranium survey aircraft to measure the altitude concentration of radon and/or its daughters through the use of the fluorescence produced by direct excitation of these elements by laser radiation or the time-dependent signal resulting from the backscattering of laser radiation by atmospheric aerosols. Studies were also undertaken to determine the ability changes in the aerosol content as well as the ability to detect the presence of a temperature inversion and to measure the distance above or below an airborne platform at which the temperature inversion occurs. A review was made of the currently available laser systems that could be used in airborne applications. Recommendations are made for a possible system that could be installed on one of the aircraft currently making airborne radiometric measurements in the National Uranium Resource Evaluation Program.

MINING

REFER ALSO TO CITATION(S) 25362, 25954

25345 (SAND—79-0973) **State policies and requirements for management of uranium mining and milling in New Mexico. Vol. I. Executive summary.** Vandevender, S.G. (Sandia Labs., Albuquerque, NM (USA)). Feb 1980. Contract AC04-76DP00789. 73p. NTIS, PC A04/MF A01.

This volume summarizes the results of a cooperative effort with the State of New Mexico to study the potential environmental and resource-related problems associated with uranium mining and milling. Four issues identified in a conference jointly sponsored by the state and DOE's predecessor, ERDA, were addressed by three state agencies: The Office of the State Engineer, the Environmental Improvement Agency (EIA), and the Energy Resources Board. The individual studies of water availability, environmental quality, power availability and community impacts are published separately as Volumes II-V of this report. The recommendations are that DOE consider proposals from the State Engineer and the Environmental Improvement Division to develop programs which would lead to resolution of the issues they have presented. It is also recommended that DOE enter into discussions with the State Energy and Minerals Department (formerly ERB) to determine whether and to what extent DOE participation in their recommended programs is appropriate.

25346 (SAND—79-7105) **State policies and requirements for management of uranium mining and milling in New Mexico. Volume IV. The supply of electric power and natural gas fuel as possible constraints on uranium production.** Page, G.B. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 107p. NTIS, PC A06/MF A01.

The report contained in this volume considers the availability of electric power to supply uranium mines and mills. The report, submited to Sandia Laboratories by the New Mexico Department of Energy and Minerals (EMD), is reproduced without modification. The state concludes that the supply of power, including natural gas-fueled production, will not constrain uranium production.

FEED PROCESSING

REFER ALSO TO CITATION(S) 25345, 25346, 26309

ENRICHMENT

REFER ALSO TO CITATION(S) 25443

CENTRIFUGATION

25347 (K/OA—4683) **Solution of the equation 4A^{4}h/sub xx/ + h/sub yy/ + f(x,y) = 0 to uncouple temperature and angular velocity in Onsager's pancake approximation.** Berger, M.H. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). Dec 1979. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01.

The auxiliary equation to uncouple temperature and angular velocity in the PANCAKESS code is presented in the context of the complete system of linearized continuum equations governing steady state centrifuge gas dynamics. This single, second order, anisotropic diffusion equation is carefully examined, and boundary layer-like character under high-speed conditions ($A^2 >> 1$) is identified through physical reasoning. Both exact and perturbation solutions are constructed for the main drive mechanisms of interest, (e.g., wall temperature, end cap temperature, scoop and feed). Several analytical solutions are greatly simplified in the perturbation approximation of matched asymptotic expansions and simultaneously reduce computational labor. As a result, the physics of this process is described in several cases of interest by very simple expressions.

FUELS PRODUCTION AND PROPERTIES

25348 (AGNS—35900-CONF-69) **Conversion of mixed plutonium-uranium oxides.** Thomas, L.L. (Allied-General Nuclear Services,

Barnwell, SC (USA)). Apr 1980. Contract AC09-78ET35900. 23p. (CONF-800802—7). NTIS, PC A02/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

Coprocessing is among the several reprocessing schemes being considered to improve the proliferation resistance of the back end of the nuclear fuel cycle. Coconversion of mixed oxides has been developed but not demonstrated on a production scale. AGNS developed a preliminary conceptual design for a production scale facility to convert mixed plutonium-uranium nitrate to the mixed oxide.

25349 (HEDL-SA—1706) **Fuel fabrication instrumentation and control system for remote operation.** Fritz, R.L.; Hubbard, J.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1979. Contract EY-76-C-14-2170. 22p. (CONF-790602—94). NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979). Portions of document are illegible.

In order to direct and coordinate operations of fuel fabrication and maintenance equipment, an instrumentation and control system has been developed utilizing the latest technological components available in the minicomputer and microcomputer industry. A distributed control structure is employed that offers special features for system operation, reliability, maintenance and expansion. The control system is responsible for data acquisition, data recording, data analysis, maintenance diagnostics, and accountability reporting.

25350 (ORNL/TM—7254) **Detection and control of as-produced pyrocarbon permeability in biso-coated high-temperature gas-cooled reactor fuel particles.** Stinton, D.P.; Thiele, B.A.; Lackey, W.J.; Morgan, C.S. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01.

About 60 Biso-coated particle batches with coatings deposited in either 0.13- or 0.24-m dia coaters were studied in this work. These batches were carefully characterized for permeability by neon-helium intrusion, long-term chlorination followed by radiography, and fission gas release. These methods of permeability measurement were compared and correlated with deposition conditions as well as pyrocarbon properties. The results from several irradiation tests were also used to evaluate the validity of the permeability measurements. The neon-helium and long-term chlorination techniques correlated very clearly. Coatings with neon-to-helium ratios below 0.3 were gastight by the chlorination procedure, whereas those with ratios above 0.4 were permeable. The fission gas release technique was unable to distinguish between slightly permeable coatings and gastight ones. Therefore, neon-helium and long-term chlorination procedures are preferred over the fission gas release technique. Results from several irradiation tests verified that coatings with neon-to-helium ratios below 0.3 were gastight, whereas those with ratios above about 0.4 were permeable. 10 figures, 2 tables.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 25359, 25431, 25434, 25435, 25436, 25903, 26176

25351 (CONF-791184—1) **Separation of uranium from process wastewaters using microbial cells as sorbents.** Shumate, S.E. II; Strandberg, G.W.; Parrott, J.R. Jr.; Locke, B.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 17p. (CONF-791072—4). NTIS, PC A02/MF A01.

From 9. annual hydrometallurgical meeting; Toronto, Canada (11 Nov 1979).

A mixed culture of denitrifying bacteria was evaluated for separating U from process wastewaters. The mixed culture was obtained as films on coal particles in an operating fluidized-bed bioreactor system. Biosorption of U by the mixed culture was rapid, reaching a saturation of ~ 0.14 g U per gram of dry cells. Two contacting devices were also evaluated. 4 figures. (DLC)

25352 (DP—1549) **Electrolytic production of uranous nitrate.** Orebaugh, E.G.; Propst, R.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1980. Contract AC09-76SR00001. 31p. NTIS, PC A03/MF A01.

Efficient production of uranous nitrate is important in nuclear fuel reprocessing because U(IV) acts as a plutonium reductant in solvent extraction and can be coprecipitated with plutonium and/or throium as oxalates during fuel reprocessing. Experimental conditions are described for the efficient electrolytic production of uranous nitrate for use as a reductant in the SRP Purex process. The bench-scale, continuous-flow, electrolysis cell exhibits a current efficiency approaching 100% in combination with high conversion rates of U(VI) to U(IV) in simulated and actual SRP Purex solutions. High current efficiency is achieved with a voltage-controlled mercury-plated platinum electrode and the use of hydrazine as a nitrite scavenger. Conversion of U(VI) to U(IV) proceeds at 100% efficiency. Cathodic gas generation is minimal. The low rate of gas generation permits a long residence time within the cathode, a necessary condition for high conversions on a continuous basis. Design proposals are given for a plant-scale, continuous-flow unit to meet SRP production requirements. Results from the bench-scale tests indicate that an 8-kW unit can supply sufficient uranous nitrate reductant to meet the needs of the Purex process at SRP.

25353 (DP-MS—80-38) **Chemical studies for alternate fuel cycles at the Savannah River Laboratory.** Peterson, S.F.; Cadieux, J.R.; Pickett, J.B.; Reif, D.J.; Stone, J.A.; Thompson, M.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 13p. (CONF-800802—1). NTIS, PC A02/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

The Savannah River Laboratory has been involved since 1975 in the Department of Energy program to assist industry in the commercialization of the Light Water Reactor Fuel Cycle. beginning in 1978, emphasis hs been placed on alternative fuel cycles. The SRL chemical studies for alternative fuel cycles will be discussed.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 25432, 26227, 26228, 26229, 26231

25354 **Method for storing nuclear fuel in respositories.** Schweitzer, D.G.; Sastre, C. US Patent Application 070,548. [nd]. 5p.

A method for storing radioactive spent fuel in repositories containing polyphenyl or silicon oil as the storage medium is disclosed. Polyphenyls and silicon oils are non-corrosive and are not subject to radiation damage. Thus, storage periods of up to 100 years are possible.

25355 **Method for storing spent nuclear fuel in repositories.** Schweitzer, D.G.; Sastre, C.; Winsche, W. US Patent Application 068,359. [nd]. 8p.

A method for storing radioactive spent fuel in repositories containing sulfur as the storage medium is disclosed. Sulfur is noncorrosive and not subject to radiation damage. Thus, storage periods of up to 100 years are possible.

25356 (DOE/NV/10061—1) **Spent fuel handling and packaging program. Quarterly report, October-December 1979.** Durrill, D.C. (Westinghouse Electric Corp., Mercury, NV (USA). Advanced Energy Systems Div.). Jan 1980. Contract AC08-80NV10061. 13p. NTIS, PC A02/MF A01.

Balance of 13 fuel assemblies for the Climax programs were received; 9 were completely encapsulated, 4 were canistered without welding; all were placed in Hot Bay lag storage. Six Climax electrically heated mockup assemblies (EHMA) were pre-assembled at E-MAD, delivered to the Climax site and assembly was completed. The BWR fuel handling tool was fabricated and proof tested. The new constant air monitor (CAM) equipment was received. Fuel Temperature Test controller modifications were completed and testing was resumed. Calorimeter equipment installation was resumed; modification of lower vertical supports was completed; and the first review draft of the operating procedure was issued. The Lag Storage Pit ventilation test was completed.

25357 (DOE/NV/10061—2) **Spent fuel handling and packaging program. Quarterly report, January-March 1980.** Durrill, D.C. (Westinghouse Electric Corp., Mercury, NV (USA). Advanced Energy Systems Div.). Apr 1980. Contract AC08-80NV10061. 17p. NTIS, PC A02/MF A01.

The following was completed: calorimeter equipment modification, installation, calibration and checkout, climax canister thermocouple channel/Climax shield plug alignment checks, Climax canister/shield plug/dummy fuel lifting force measurement, 1 KW PWR Fuel Temperature Test, and lag Storage Pit radiation background measurement study.

25358 (PNL—3268) **Criticality safety considerations in the geologic disposal of spent nuclear fuel assemblies.** Gore, B.F.; McNair, G.W.; Heaberlin, S.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-76RL01830. 53p. NTIS, PC A04/MF A01.

Features of geologic disposal which hamper the demonstration that criticality cannot occur therein include possible changes of shape and form, intrusion of water as a neutron moderator, and selective leaching of spent fuel constituents. If the criticality safety of spent fuel disposal depends on burnup, independent measurements verifying the burnup should be performed prior to disposal. The status of nondestructive analysis method which might provide such verification is discussed. Calculations were performed to assess the potential for increasing the allowed size of a spent fuel disposal

canister if potential water intrusion were limited by close-packing the enclosed rods. Several factors were identified which severely limited the potential of this application. The theoretical limit of hexagonal close-packing cannot be achieved due to fuel rod bowing. It is concluded that disposal canisters should be sized on the basis of assumed optimum moderation. Several topics for additional research were identified during this limited study.

25359 (UCID—18143) **Storage of radioactive solutions, evaporation and radiolysis losses from tanks containing plutonium nitrate solutions.** Maimoni, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 16p. NTIS, PC A02/MF A01.

The processes leading to mass loss from storage tanks containing radioactive solutions are examined and the methods applied to the estimation of material losses from plutonium nitrate storage tanks, such as those at the Allied General reprocessing plant at Barnwell, South Carolina. The mass loss rate is about 480 g/day from a full tank, of which approximately 98% is water.

25360 (UNI-SA—74) **Restoration of an irradiated fuel storage facility.** Wahlen, R.K. (United Nuclear Industries, Inc., Richland, WA (USA)). 1980. Contract EY-76-C-06-1857. 13p. (CONF-800542—1). NTIS, PC A02/MF A01.

From Concrete decontamination workshop; Seattle, WA, USA (28 May 1980).

The irradiated fuel storage basin in the KW nuclear production reactor at the Hanford Site in Richland, Washington, was decontaminated and painted in preparation for converting the facility to storage of irradiated fuel from N reactor. Corrosion product, activation product, and some fission product built up in the basin over the years and was present in a layer of sludge about 3 inches deep on the basin floor. The solid waste was packaged in approved containers and buried in the 200 Area burial site on the Hanford Project. The concrete walls and pillars in the basin were decontaminated with a high-pressure aqua-blaster. Using a water jet, the sludge was flushed to a sump where it was picked up with a sludge pump and deposited in a crib which was formed in the basin area using a bulkhead to isolate the crib from the basin. After decanting the excess water from the sludge, it was pumped to a large tank designed to meet the burial and transport regulations. The tank containing the sludge was then transferred to the 200 Area burial site and placed in the burial trench. The cement walls, floor, and columns were painted with an epoxy paint. This paper reviews the procedures and techniques used in cleaning the storage basin.

25361 (PNL-TR—399) **Permanent storage facility for spent fuel assemblies.** Klein, D.; Stuger, R. Translated from *Atomwirtsch., Atomtech.*; 401-403(Sep 1978). 11p. NTIS, PC A02/MF A01.

The capital costs for a permanent storage facility for spent LWR fuel assemblies with a storage capacity of 540 tons of uranium and with its own infrastructure lie on the order of ca. 260 DM/kg U. In the operating costs, a distinction must be made between costs in the charging stage and costs during the subsequent storage period. The specific operating costs amount to ca. 9 DM/kg U during the charging stage and decrease to 3 to 4 DM/kg U during exclusive storage operation. In conclusion, this prototype shows: fuel assemblies can be admitted to an air-cooled storage facility as early as a few years after their removal from the reactor, without being subjected to initial temperature stresses in excess of those during the preceding reactor operation. The system in which the fuel assemblies are cooled by natural convection of outside air offers inherent safety and low operating expenses. Radiological pollution of the environment can be reduced to extremely low levels by suitable precautions.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25361, 25430, 25982

25362 (GJO—103(80)) **Uranium exploration expenditures in 1979 and plans for 1980-1981.** (Bendix Field Engineering Corp., Grand Junction, CO (USA)). May 1980. Contract EY-76-C-13-1664. 15p. NTIS, PC A02/MF A01.

The Grand Junction Office has conducted annual surveys of actual and planned uranium exploration activities since 1971. This work is part of an overall program to evaluate future supplies of nuclear fuel. The annual surveys have covered: (1) land acquired for exploration and cost of acquisition (since 1966); (2) surface drilling footage and cost (since 1966); (3) all other exploration expenditures (since 1966); (4) estimates of exploration activities and costs for 1980-81; (5) exploration for non-sandstone deposits (since 1974); (6) exploration for non-established areas (since 1974); (7) foreign uranium exploration expenditures by US companies (since 1966); (8) foreign participation in exploration activities in the United States (since 1976); (9) aerial radiometric exploration activities (since 1977); and (10) solution mining production drilling (since 1976). This report presents a compilation of data from the replies of 164 companies. The results of this year's survey as compared with data from the previous 13-year period are summarized. Total surface drilling, as reported on questionnaires, was 41.1 million feet in 1979. This footage is 15% lower than the previous record high of 48.1 million feet reported for 1978. Total exploration expenditures for 1979 were $315.9 million, which included $44.5 million for land acquisition, $163.0 million for surface drilling, and $108.4 million for other related exploration activities. The total expenditures for 1979 are slightly higher than the previous record of $314.3 million reported for 1978. The industry's planned exploration expenditures are $277 million in 1980 and $271 million in 1981. These plans include 39.4 million feet of surface exploration and development drilling in 1980 and 35.5 million feet in 1981.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26182, 26462

25363 (CONF-791112—66) **Systematic approach for assessment of alternative nuclear waste management strategies.** Yeh, G.T. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

A systematic approach for alternative nuclear waste management assessment is prescribed for evaluating the fate and transport of radwaste in the environment and to man. The approach consists of a system of flow dynamic and waste transport models for the physical environment, transfer models to biota, and dose models to man. Flow dynamic and waste transport models are included for computing spatial-temporal variations of the flow field and radwaste concentration in subsurface aquifers, surface water regimes, estuaries/oceans, and the atmosphere. Transfer models are linked to flow dynamic and waste transport models to study the uptake from and to the physical environment of the waste by aquatic and terrestrial biota. Dose models are used to compute both the radwaste input to man and its effects on man. With these series of computations, the radiation dose from alternative nuclear waste management strategies can be computed. Coupled with the exposure and effect analysis, the approach should facilitate the selection of the best management methodologies among many alternatives.

25364 (CONF-800535—3) **Overview of radioactive waste management.** Ritter, G.L. (EG and G Idaho, Inc., Idaho Falls (USA)). 29 May 1980. Contract AC07-76ID01570. 4p. NTIS, PC A02/MF A01.

From ASME Idaho section symposium; Idaho Falls, ID, USA (29 May 1980).

The question of what to do with radioactive wastes is discussed. The need to resolve this issue promptly is pointed out. Two significant events which have occurred during the Carter administration are discussed. An Interagency Review Group (IRG) on waste management was formed to formulate recommendations leading to the establishment of a National policy for managing radioactive wastes. The technical findings in the IRG report are listed. The author points out some issues not addressed by the report. President Carter issued a national policy statement on Radioactive Waste Management in February 1980. The most significant elements of this statement are summarized. The cancellation of the Waste Isolation Pilot Plant is currently meeting opposition in Congress. This and other items in the National Policy Statement are discussed.

25365 (LA—8294-MS) **Measurement of uranium and plutonium in solid waste by passive photon or neutron counting and isotopic neutron source interrogation.** Crane, T.W. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 96p. NTIS, PC A05/MF A01.

A summary of the status and applicability of nondestructive assay (NDA) techniques for the measurement of uranium and plutonium in 55-gal barrels of solid waste is reported. The NDA techniques reviewed include passive gamma-ray and x-ray counting with scintillator, solid state, and proportional gas photon detectors, passive neutron counting, and active neutron interrogation with neutron and gamma-ray counting. The active neutron interrogation methods are limited to those employing isotopic neutron sources. Three generic neutron sources (alpha-n, photoneutron, and ^{252}Cf) are considered. The neutron detectors reviewed for both prompt and delayed fission neutron detection with the above sources include thermal (^{3}He, $^{10}BF_3$) and recoil (^{4}He, CH_4) proportional gas detectors and liquid and plastic scintillator detectors. The instrument found to be best suited for low-level measurements (< 10 nCi/g) is the ^{252}Cf Shuffler. The measurement technique consists of passive neutron counting followed by cyclic activation using a ^{252}Cf source and delayed neutron counting with the source withdrawn. It is recommended that a waste assay station composed of a ^{252}Cf Shuffler, a gamma-ray scanner, and a screening station be tested and evaluated at a nuclear waste site. 34 figures, 15 tables.

25366 (LA-UR—80-1289) **Recent developments at Los Alamos for the measurement of alpha contaminated waste.** Caldwell, J.T.; Cates, M.R.; Close, D.A.; Crane, T.W.; Kunz, W.E.; Shunk, E.R.; Umbarger, C.J.; Franks, L.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 18p. (CONF-800611—4; IAEA-SM—246/67). NTIS, PC A02/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

A comprehensive program is currently in progress for the development of sensitive, practical nondestructive assay techniques for the quantification of low level transuranics in bulk solid wastes. This program encompasses a broad range of nuclear and nonnuclear techniques including sophisticated passive gamma-ray and passive neutron detection systems, isotopic neutron source-based active interrogation systems, pulsed portable neutron generator active interrogation systems, electron accelerator based techniques and laser spectroscopy techniques. The mix of techniques ranges in development maturity from the well established (MEGAS, Shuffler, Passive 4π neutron counters) through the proof-of-principle stage (pulsed neutron generator techniques) to the under investigation stage (electron linac and laser spectroscopy techniques). Matrix compensation methods are being developed to improve the accuracy of waste screening and assay measurements. Specific detection systems have been designed to operate in the high level beta-gamma backgrounds associated with some commercial reactor wastes. The techniques being developed can be used with either low level or high level beta-gamma wastes in either low density or high density matrices.

25367 (LA-UR—807145) **Liquid waste management systems improvement programs at Los Alamos Scientific Laboratory.** Emelity, L.A.; Stanley, P.M.; Buchholz, J.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 28p. (CONF-800611—6). Dep. NTIS, PC A03/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

Programs at the Los Alamos Scientific Laboratory (LASL) are approximately 50% nuclear weapons related and 50% general energy research and development. Since its beginning in the 1940's liquid industrial wastes have been contaminated with isotopes of plutonium, americium, uranium and various beta-gamma emitters, but management and treatment efforts were, due to the proportions of the various isotopes, directed primarily at the alpha emitters. The evolution in management methods at LASL since the 40's has been reported in previous papers. This treatise discusses the most recent three-phase effort to modernize the systems to the probable standards of the next twenty years. The first phase, provision of double-encased, continuously monitored sewer system will soon be under construction. The second phase, modernization of the treatment facilities, has been funded and is in the final design stage. The third phase, not funded as of this date, will provide lined, monitored solar evaporation ponds for total management of the treated industrial wastes with no release of any liquid to the environment.

25368 (MLM—2669) **Trittium waste control: April-September 1979.** (Mound Facility, Miamisburg, OH (USA)). 21 Dec 1979. Contract AC04-76DP00053. 28p. NTIS, PC A03/MF A01.

The Combined Electrolysis Catalytic Exchange (CECE) pilot unit has been modified. Start-up of these components has been completed. The 1 Ci/ml test of the solid polymer electrolyte (SPE) membrane was successfully terminated after 29 weeks and the 10 Ci/ml test was initiated immediately using the same cell and SPE membrane. The cryogenic distillation system was successfully integrated with the combined electrolysis catalytic exchange system; with a HT gas mixture containing 1000 Ci/m^3, 0.1 mole % tritium were completed with the integrated system. A high beam quality Nd:YAG pump laser based on an unstable resonator/far-field converter design was developed to pump the angle tuned optical parametric oscillator (OPO) for the ir excitation step in the H_2O/HTO separation. Absorption measurements were made. Gas generation rates caused by radiolysis of tritium waste materials were determined for polymer and non-polymer impregnated tritiated concrete and fixated and non-fixated tritiated waste vacuum pump oil. The pressure change of hydrogen cover gas over tritiated water on cement-plaster was also determined. Tests continue on samples of cement and cement-plaster mixtures which were injected with 386 Ci of tritiated water, cured and then impregnated with catalyzed styrene monomer which were polymerized. After 46 weeks the tritium released from the styrene-impregnated cement blocks equals only one half of the tritium released from the cement block without styrene impregnation. Two of the drums containing waste octane have now been packaged 7.5 y and show a release of 17 mCi. Another drum containing approximately 35,000 Ci of tritiated water solidified on cement, shows a release of nearly 21 mCi after 5 y.

25369 (MLM—2714) **Tritium waste control, October 1979-March 1980.** (Mound Facility, Miamisburg, OH (USA)). 19 May 1980. Contract EY-76-C-04-0053. 23p. NTIS, PC A02/MF A01.

Modifications were made to the Combined Electrolysis Catalytic Exchange (CECE) pilot unit. After the SPE cell was dismantled to investigate a water circulation problem, an internal short circuit developed. Analyses were done for impurities in the CECE system; the problem appears to be a 1 to 2% oil (mostly insoluble organics) layer. A polystyrene-impregnated, tritiated-concrete waste package was prepared with 7921 Ci of tritium. The study of tritium release from representative burial packages was continued. Gas generation rates were determined for polymer and non-polymer impregnated tritiated concrete and fixated and non-fixated tritiated waste vacuum pump oil. The pressure change of hydrogen cover gas over tritiated water on cement-plaster was determined.

25370 (ORNL/SUB—80/13837/3) **Programmatic assessment of radioactive waste management: nuclear fuel and waste programs.** (Gilbert/Commonwealth, Reading, PA (USA)). Jun 1980. Contract W-7405-ENG-26. 135p. NTIS, PC A07/MF A01.

Gilbert/Commonwealth (G/C) has performed an assessment of the waste management operations at Oak Ridge National Laboratory (ORNL). The objective of this study was to review radioactive waste management as practiced at ORNL and to recommend improvements or alternatives for further study. The study involved: (1) an on-site survey of ORNL radioactive waste management operations; (2) a review of radioactive waste source data, records, and regulatory requirements; (3) an assessment of existing and planned treatment, storage, and control facilities; and (4) identification of alternatives for improving waste management operations. Information for this study was obtained from both personal interviews and written reports. The ORNL waste management operations have maintained radioactive releases to the environment well below regulatory requirements and have been successful, in recent years, in consistently reducing emissions. This has been accomplished primarily by upgrading equipment and procedures. However, this upgrading must be an on-going activity because of: (1) the changing nature of ORNL activities; (2) an increase in radioactive burden on-site; (3) the age of existing facilities and equipment; and (4) changes to regulatory requirements. As a result of reviewing ORNL operations, specific suggestions are offered for resolving isolated problems. However, these suggestions should be considered in the context of a comprehensive plan for the management of radioactive wastes at ORNL. Three areas were determined to warrant more detailed, consolidated studies: (1) waste management program planning; (2) development of a centralized computer based data acquisition system; and (3) a review for maintaining exposures to on-site personnel as low as reasonably achievable (ALARA).

25371 (RHO-CD—761) **Cost/risk/benefit analysis report on the decontamination and decommissioning of Z-plant.** Melvin, J.P.; Sexton, R.A.; Fort, M.L.; Nunn, S.E. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). 28 Sep 1979. Contract AC06-77RL01030. 104p. NTIS, PC A06/MF A01.

This study was performed to estimate the cost of decontaminating and decommissioning Z-Plant. All of the buildings in the Z-Plant exclusion area except Building 2736-Z, the plutonium storage vault, are included in the study. The study also excludes all underground facilities within the exclusion area which are not contained within a building and all Z-Plant related facilities outside the perimeter fence. The contamination in Z-Plant is primarily ^{239}Pu which has a half-life of 24,360 years. Because of the long half-life of ^{239}Pu, it is not practical to consider the isolation of the facility to await reduction of the contamination level by natural decay. Therefore, this study analyzes the costs, risk and benefit of decontaminating Z-Plant to four different levels of residual contamination. The three principle criteria used in the analysis are cost, the risk of offsite dose to the public, and the occupational exposure to onsite personnel.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 25351, 26176

25372 (DP-MS—79-91) **Alternative solid forms for Savannah River Plant defense waste.** Stone, J.A.; Goforth, S.T.; Smith, P.K. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC090-76SR00001. 14p. (CONF-800460—4). NTIS, PC A02/MF A01.

From 82. annual American Ceramic Society meeting; Chicago, IL, USA (27 Apr 1980).

Solid forms and processes were evaluated for immobilization of SRP high-level radioactive waste, which contains bulk chemicals such as hydrous iron and aluminium oxides. Borosilicate glass currently is the best overall choice. High-silica glass, tailored ceramics, and coated ceramics are potentially superior products, but require more difficult processes.

25373 (DP-MS—80-2) **Small-scale demonstration of high-level radioactive waste processing and solidification using actual SRP waste.** Okeson, J.K.; Galloway, R.M.; Wilhite, E.L.; Woolsey, G.B.; Ferguson. R.B. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 33p. (CONF-800802—2). NTIS, PC A03/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

A small-scale demonstration of the high-level radioactive waste solidification process by vitrification in borosilicate glass is being conducted using 5-6 liter batches of actual waste. Equipment performance and processing characteristics of the various unit operations in the process are reported and, where appropriate, are compared to large-scale results obtained with synthetic waste.

25374 (LA-UR—80-1408) **Radioactive waste incineration studies at the Los Alamos Scientific Laboratory.** Stretz, L.A.; Borduin, L.C.; Draper, W.E.; Koenig, R.A.; Newmyer, J.M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 20p. (CONF-800607—53). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Development and demonstration of a transuranic (TRU) waste volume-reduction process is described. A controlled-air incinerator, based upon commercially available equipment and technology, was modified for radioactive service and was successfully tested and demonstrated with contaminated waste. Demonstration of the production-scale unit was completed in May 1980 with the incineration of 272 kg of waste with an average TRU content of about 20 nCi/g. Weight and volume reduction factors for the demonstration run were 40:1 and 120:1, respectively.

25375 (MLM—2716) **Defense waste cyclone incinerator demonstration program: October 1979-March 1980.** Klingler, L.M. (Mound Facility, Miamisburg, OH (USA)). 6 Jun 1980. Contract AC04-76DP00053. 25p. NTIS, PC A02/MF A01.

An improved offgas system is being designed. Significant system modifications will be required for the commercial incinerator full-scale experimentation program planned for later this year. Cost estimates indicated that a number of desired system improvements can be made at the same time for little additional cost. The new system layout will also provide needed space for possible future expansion of incinerator throughput capabilities. Continuous solid and liquid feed experimentation is in progress. Continuous burning is presently being initiated by means of a small batch burn. As the batch burn nears completion, continuous solid feeding is begun. In the limited burning done to date, the feed system has worked extremely well. Liquid burning has been conducted in coordination with continuous solid feed burning. As the solids feed rate is reduced, a liquid stream is introduced to the chamber at another air inlet. Limited burning indicated that both feed systems will work as expected. Combustion quality appears to be excellent, and the burning is smooth and controllable. Efforts are being made to upgrade the offgas sampling program for the incinerator. System changes will include provisions for good sampling procedure.

25376 (MLM—2717) **Pelletized waste form demonstration program, October 1979-March 1980.** Lewis, E.L.; Herbert, R.F. Jr. (Mound Facility, Miamisburg, OH (USA)). 6 Jun 1980. Contract AC04-76DP00053. 12p. NTIS, PC A02/MF A01.

The main objective of this task is to evaluate several transuranic waste immobilization methods. During the first half of FY-1980, ash/cement and sludge/cement pellets were performance tested. In short-term radiolysis experiments with sludge/cement pellets, a very low hydrogen generation rate of 0.01 molecule/100 eV was obtained. Leachability testing of ash/cement and sludge/cement pellets containing plutonium-238 oxide in both brine and deionized water yielded a very low leach rate of $< 10^{-5}$ (fraction leached) (g) $(cm)^{-2}$ $(day)^{-1}$. Pressed waste/cement pellets, therefore, appear to be an excellent final waste form based on leachability and radiolysis results. Design criteria were developed for the production waste pelletization line (PWPL) and documented. Equipment procurement for the PWPL was started, and installation will be continuing for several months.

25377 (MLM—2731) **Commercial cyclone incinerator demonstration program: October 1979-March 1980.** Alexander, B.M. (Mound Facility, Miamisburg, OH (USA)). 21 May 1980. Contract EY-76-C-04-0053. 15p. NTIS, PC A02/MF A01.

The commercial cyclone incinerator program was designed to study the effects of burning low-level waste contaminated with beta and gamma emitters in a cyclone system. The ultimate program goal is the demonstration of a cyclone incinerator at a nuclear power plant. During the past six months, progress was made toward achieving the second program objective, Complete Incinerator Feasibility Plan. Forty-one laboratory-scale experiments were completed, with five more experiments remaining to be performed. Sample analysis from completed experiments continues. A promising scrub liquor was identified and is now being used for improved absorption of iodide and chloride from incinerator offgas. Inconel 601 continues to perform well as the material of construction for the laboratory-scale burn chamber. 7 figures, 7 tables.

25378 (ORNL/TM—6802) **Recovery of plutonium from HEPA filters by Ce(IV): promoted dissolution of PuO_2 and recycle of the cerium promoter.** Scheitlin, F.M.; Bond, W.D. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 58p. NTIS, PC A04/MF A01.

Studies carried out in this investigation included (1) electrolytic production of Ce(IV) from Ce(III), (2) leaching of refractory PuO_2 from HEPA filters with maintenance of Ce(IV) by anodic oxidation during leaching, and (3) evaluation of methods for contacting the HEPA solids with the leaching solution and for separating the solid residue from the leaching liquor. Anodic oxidation of Ce(III) was accomplished with an electric current efficiency of about 85% at current densities of 0.04 to 0.4 A/dm^2 at Pt anode. Refractory PuO_2 was dissolved by a 4.0 M HNO_3 - 0.1 M Ce(IV) solution in 1.5 h at 100°C using stirred-contact leaching of the solids or by recirculating the leachant through a packed column of the solids. Cerium(IV) concentrations were maintained continuously by anodic oxidation throughout leaching. Dissolution times up to 10 h were required unless the HEPA media were oxidized initially in air at 300°C to destroy carbonaceous species which consumed Ce(IV) more rapidly than it could be regenerated be anodic oxidation. Leaching solids in packed columns avoided the relatively difficult liquid-solids separation by centrifugation which was required after stirred-contact leaching; however, the solids handling difficulties remain. A flowsheet is proposed for the recovery of actinides from HEPA filters. A 4 M HNO_3 - 0.1 M Ce(IV) nitrate solution is used as the leachant and the Ce(III) is recycled to the leaching operation using bidentate solvent extraction.

25379 (ORNL/TM—7102) **Scrubbing of iodine from gas streams with mercuric nitrate-conversion of mercuric iodate product to barium iodate for fixation in concrete.** Rogers, G.C.; Moore, J.G.; Morgan, M.T. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

A bench-scale model of a mercuric nitrate scrubber for removal of iodine from off-gas streams was constructed and operated in conjunction with a mercuric iodate-to-barium iodate conversion system to determine the feasibility of total recycle of all processing solutions. The two main aspects of the system examined were (1) the extent of contamination of the barium iodate product, and (2) the effect of cross-contamination of various process solutions on the efficiency of the process. The experimental evidence obtained indicates that, with appropriate control, all solutions can be recycled without significant contamination of the product that would be harmful to the host concrete or to the environment. Mercury contamination was found to be $\leq$ 0.5 wt % of the barium iodate product. The most significant effect on system efficiency was determined to be barium hydroxide contamination of the sodium hydroxide solution used to convert mercuric iodate to sodium iodate. A mole ratio of barium hydroxide to sodium hydroxide of about 1:225 caused a decrease in conversion efficiency of about 45%.

25380 (PNL—3027) **Design features of the laboratory-scale radiochemical immobilization system.** Hanson, M.S.; Knox, C.A.; Berger, D.N. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-76RL01830. 46p. NTIS, PC A03/MF A01.

Under the High-Level Waste Immobilization Program, the Pacific Northwest Laboratory (PNL) is studying various ways to solidify high-level nuclear wastes. A variety of waste forms and processes are being investigated, with the most highly developed process being spray calcination coupled with in-can melting. This report describes a remote laboratory-scale system that was designed for the purpose of investigating the effects of different operating conditions and waste compositions on the product and on the effluents generated. It is termed laboratory-scale because of its nominal 1 L/h feed rate as compared to well over 300 L/h for full-scale equipment at PNL. The equipment currently consists of a feed system, a spray calciner, an in-can melter, and an effluent control system. It is operated in a shielded radiochemical hot cell using radioactive high-level liquid waste (HLLW) to answer questions on the deposition of radiochemicals during actual waste processing. The effluent control system can be modified in order to test different effluent systems, one of which has been proposed by the Savannah River Laboratories (SRL) for use in the Savannah River Plant vitrification system. The laboratory-scale system can also be used to test alternative immobilization processes, since spray calcination is a common processing step in many alternative waste form flowsheets. Thus, only the addition of a specific forming step such as pelletizing or sintering is necessary.

25381 (RHO-LD—80-101-A) **Long-term high-level defense waste technology progress report, October-December 1979.** (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Feb 1980. Contract AC06-77RL01030. 25p. NTIS, PC A02/MF A01.

The highlights of the quarter in program management and support, waste preparation, and waste fixation are reported. Technical progress in environmental and safety assessments, in situ storage, waste retrieval, separation and concentration, waste form develop-

ment and characterization, and process and equipment development is discussed. (DC)

25382 Separation of ^{137}Cs from nuclear waste. Kenna, B.T.; Murphy, K.D. (Sandia Labs., Albuquerque, NM (USA)). *J. Inorg. Nucl. Chem.;* **41**: No. 11, 1535-1540(1979).

Sodium zirconate is one member of a family of new inorganic ion exchange materials which have high affinity for all actinides and fission product cations except for Cs^+. A combination of cold, tracer and high level liquid waste experiments with sodium zirconate has shown that 70 to 80 and 80 to 100% of the Cs^+ in high level liquid waste remains in solution following batch or column equilibration, respectively. The fact that ^{137}Cs can be obtained in relatively pure form permits subsequent conversion directly to an insoluble radiation source. This is of prime importance in areas such as sewage sludge sterilization via γ-ray irradiation.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 25354, 25355, 25361, 25381, 25426, 25427, 26319, 26456, 26463

25383 (DOE/SR-SF—2004(Rev.1)) **Reracking to increase spent fuel storage capacity.** (Department of Energy, Aiken, SC (USA). Savannah River Operations Office). May 1980. 12p. NTIS, PC A02/MF A01.

Many utilities have already increased their spent fuel pool storage capacity by replacing aluminum racks having storage densities as low as 0.2 MTU/ft² with stainless steel racks which can more than double storage densities. Use of boron-stainless steel racks or thin stainless steel cans containing reassembled fuel rods allows even higher fuel storage densities (up to approximately 1.25 MTU/ft²). This report evaluates the economics of smaller storage gains that occur if pools, already converted to high density storage, are further reracked.

25384 (DP-MS—80-4) **Sensitivity calculations for low heat generating defense waste repository temperatures.** Tennant, M.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 21p. (CONF-800723—14). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Repository temperatures were calculated for Savannah River wastes by using both two- and three-dimensional numerical schemes. The error introduced by using the simpler and more efficient two-dimensional models is less than the present uncertainties introduced by waste power generation and host rock properties. Waste canister temperatures were found to be relatively insensitive to geometric asymmetry and model detail.

25385 (DP-MS—80-7) **Comparison of laboratory, in situ, and rock mass measurements of the hydraulic conductivity of metamorphic rock at the Savannah River Plant near Aiken, South Carolina.** Marine, I.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 18p. (CONF-800556—1). NTIS, PC A02/MF A01.

From Annual spring meeting of the American Geophysical Union; Toronto, Ontario, Canada (22 May 1980).

In situ testing of exploratory wells in metamorphic rock indicates that two types of fracturing occur in the rock mass. Rock containing small openings that permit only extremely slow movement of water is termed virtually impermeable rock. Rock containing openings of sufficient size to permit transmission of water at a significantly faster rate is termed hydraulically transmissive rock. Laboratory methods are unsuitable for measuring hydraulic conductivity in hydraulically transmissive rock; however, for the virtually impermeable rock, values comparable to the in situ tests are obtained. The hydraulic conductivity of the rock mass over a large region is calculated by using the hydraulic gradient, porosity, and regional velocity. This velocity is determined by dividing the inferred travel distance by the age of water which is determined by the helium content of the water. This rock mass hydraulic conductivity value is between the values measured for the two types of fractures, but is closer to the measured value for the virtually impermeable rock. This relationship is attributed to the control of the regional flow rate by the virtually impermeable rock where the discrete fractures do not form a continuous open connection through the entire rock mass. Thus, laboratory methods of measuring permeability in metamorphic rock are of value if they are properly applied.

25386 (HEDL-TC—1283(Rev.1)) **Data package for the Turkey Point material interaction test capsules.** Krogness, J.C.; Davis, R.B. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1980. Contract EY-76-C-14-2170. 98p. Dep. NTIS, PC A05/MF A01.

Objective of the test is to obtain interaction information on candidate package storage materials and geologies under prototypic temperatures in gamma and low-level neutron fields. This document provides a fabrication record of the experiment. (DLC)

25387 (ONWI—24) **Assumptions and ground rules used in nuclear waste projections and source term data.** Storch, S.N.; Prince, B.E. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). Sep 1979. Contract W-7405-ENG-26;AC06-76RL01830. 137p. NTIS, PC A07/MF A01.

Assumptions and ground rules of long term domestic commercial nuclear waste projections published in studies by Union Carbide's Office of Waste Isolation, Arthur D. Little, Inc., and DOE are compared to those of the Commercial Waste Management Impact Statement, prepared by Battelle Pacific Northwest Laboratory. Target capacity growths associated with these projections range from 183 to 570 GW(e) for the year 2000. Each study regards the once-through (no recycle) fuel cycle as a reference case; however, fuel cycles employing reprocessing and various recycle strategies were also considered. The studies are compared with respect to characteristics and packaging/shipment features of spent fuel and wastes generated from reprocessing and other fuel cycle activities. Issues associated with the interim storage of spent fuel are discussed along with the characteristics and issues relating to ore mill tailings and non-fuel cycle wastes. Finally, assumptions and limitations associated with certain computer codes (viz., ORIGEN, KWIKPLAN, WASPR, and DISFUL) employed in the four waste projection studies are outlined. Overall, the report is intended to serve as a guidebook in relating information contained in the published waste projection studies.

25388 (ORO—5366-T1(Vol.1)) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Volume I. Conceptual design report.** (Kaiser Engineers, Oakland, CA (USA)). Dec 1978. Contract EY-77-C-05-5366. 357p. NTIS, PC A10/MF A01.

In February 1976, the Energy Research and Development Administration (ERDA), now the Department of Energy (DOE), established a National Waste Terminal Storage (NWTS) program. As a part of this program, two parallel conceptual design efforts were initiated in January 1977. One was for deep geologic storage, in domed salt, of high level waste resulting from the reprocessing of spent fuel. The other was for deep geologic storage of unreprocessed spent fuel in bedded salt. These two concepts are identified as NWTS Repository 1 and Repository 2, respectively. Repository 2 (NWTSR2) is the concept which is covered by this Conceptual Design Report. Volume I of the conceptual design report contains the following information: physical description of the report; project purpose and justification; principal safety, fire, and health hazards; environmental impact considerations; quality assurance considerations; assessment of operational interfaces; assessment of research and development interfaces; project schedule; proposed method of accomplishment; summary cost estimate; and outline specifications. The conceptual design for Repository 2 was developed in sufficient detail to permit determination of scope, engineering feasibility, schedule, and cost estimates, all of which are necessary for planning and budgeting the project.

25389 (ORO—5366-T1(Vol.2)) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Volume II. Conceptual design report.** (Kaiser Engineers, Oakland, CA (USA)). Dec 1978. Contract EY-77-C-05-5366. 99p. NTIS, MF A01.

Portions of document are illegible.

This volume documents the conceptual design of a National Waste Terminal Storage Repository in bedded salt for spent unreprocessed nuclear fuel. Drawings and specifications are included.

25390 (ORO—5366-T3) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Special study No. 1. Twenty-five-year retrievability capital equipment cost estimate.** (Kaiser Engineers, Oakland, CA (USA)). Nov 1978. Contract EY-77-C-05-5366. 203p. NTIS, MF A01.

Portions of document are illegible.

This estimate covers capital equipment costs of facilities for the receipt, handling, and storage in bedded salt, of canistered spent fuel assemblies from both BWR and PWR commercial power plants. The estimate includes all capital equipment and replacement costs for a repository constructed in accordance with the design shown in the Conceptual Design Report (CDR), and Special Study No. 1, KE Report No. 78-60-RE for 25-year retrievability.

25391 (ORO—5366-T4) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Special study No. 1. 25-year retrievability.** (Kaiser Engineers, Oakland, CA (USA)). Dec 1978. Contract EY-77-C-05-5366. 132p. NTIS, PC A07/MF A01.

National Waste Terminal Storage Repository 2 (NWTSR2), in bedded salt, for spent unreprocessed fuel is the subject of a conceptual design project which began in January 1977. In the base conceptual design the spent fuel is to be stored in a retrievable mode

for 5 years. This report presents the results of a separate study on 25-year retrievability with open storage rooms. Drawings prepared for 25-year retrievability are only those which differ from the companion 5-year retrievability drawings which comprise Volume II of the Conceptual Design Report (CDR). NWTSR2 capital facilities originally were to be constructed in phases. Phase I was to include those facilities required for the first 5 years of operation, which were hypothesized to be from 1985 through 1990; Phase II was to include facilities required from 1991 until the capacity of the 2000-acre mine was reached. These dates are used as the basis for conceptual design and for Special Study No. 1 but do not represent actual schedule dates for the repository. The terms Phase I and Phase II are used throughout the drawings and test, so they need to be understood. However, it is not now intended to phase the capital construction because of the relatively small effort represented by Phase II surface construction. An optional future expansion of the mine, Phase III, would add 1000 acres on the end of the mine opposite the shaft pillar. The optional Phase III expansion would commence operation upon completion of Phase II operations. The drawings and design comparisons for Phase III mine operations appear only in this report.

25392 (ORO—5366-T5) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Quality assurance program for licensing.** (Kaiser Engineers, Oakland, CA (USA)). Dec 1978. Contract EY-77-C-05-5366. 83p. NTIS, PC A05/MF A01.

A National Waste Terminal Storage Repository, in bedded salt, for spent unreprocessed fuel is the subject of a conceptual design project which began in January 1977. This volume presents a preliminary quality assurance program to guide the license applicant in developing a detailed program that will be compatible with anticipated National Waste Terminal Storage (NWTSR2) contracting arrangements and provide the documentation required by regulatory bodies. This QA program is designed to provide confidence that the quality-related activities pertaining to safety-related structures, systems, and components will be identified and controlled. Specific responsibilities for quality-related activities are documented and assigned to personnel and organizations for the major phases of facility design and construction. These responsibilities encompass a broad range of activities and are addressed in this preliminary program. The quality assurance program elements are organized and discussed herein as follows: (1) quality assurance during design and construction; (2) the applicant (DOE); (3) siting contractor; (4) architect/engineer; (5) project field management; and (6) operations contractor.

25393 (ORO—5366-T6) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Special study No. 3. Waste retrieval from backfilled regions.** (Kaiser Engineers, Oakland, CA (USA)). Sep 1978. Contract EY-77-C-05-5366. vp. NTIS, MF A01.

Portions of document are illegible.

Methods and costs were studied for delayed canister retrieval from rooms that had been backfilled immediately after canister storage. The effects of this method of storage on mine geometry, thermal and rock mechanics environments, mine development and operations, mine ventilation, time schedule, retrieval machinery and safety were investigated. Salt and air temperatures were determined. Pillar width, number of rooms, extraction ratio, tonnages of mined salt, and salt handling and hoisting requirements were calculated. The required changes in mining equipment were established. Salt handling and elapsed time schedules were developed. Ventilation requirements - size and number of shafts, size the arrangement of airways, number of stacks, and size and number of fans were then calculated. The development sequence of these facilities was established. Canister retrieval problems were analyzed for canisters stuck in the hole as well as free. Retrieval methods and machinery were studied and are described. Safety with respect to both radiation and room collapse was studied and compared with CDR safety conditions. The effects of a reduced themal loading of 30 KW/acre on temperatures, room closure, mine layout, ventilation and ground control were studied and reported. A cost estimate was prepared, giving cost differentials between the base CDR costs and Special Study No. 3. Two appendices are included. The first contains nine Heat Transfer memoranda that state the thermal basis of this study. The second appendix provides a detailed operating time analysis of the retrieval machinery.

25394 (ORO—5366-T7) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel. Special study No. 1. Twenty-five-year retrievability, decommissioning cost estimate.** (Kaiser Engineers, Oakland, CA (USA)). Nov 1978. Contract EY-77-C-05-5366. 25p. NTIS, PC A02/MF A01.

This estimate covers decommissioning costs of facilities for the receipt, handling, and storage in bedded salt of canistered spent fuel assemblies from both BWR and PWR commercial power plants. The estimate includes all decommissioning costs for a repository, based on 25-year retrievability, constructed in accordance with the design shown in Conceptual Design Report (CDR), as modified by Special Study No. 1 (KE Report No. 78-60-RE) and decommissioned in accordance with the program outlined in the Conceptual Design Description Report, KE Report No. 78-58-R. Costs for Operating Contractor personnel on the site at this time are included in this report and not in the Operating Cost Estimate (KE Report 78-63-RE). The operating cost estimates end with the completion of storage room backfilling. The three major elements of decommissioning are: demolition of surface facilities, backfilling of main entries and airways, and shaft liner removal and shaft plugging. EDIT, ECON, and DELOX computer programs and a chart of accounts were furnished by UCC-ND under direction of the Government and the line item-capital-cost estimate was prepared according to the prescribed format. The decommissioning cost estimate referenced herein is in the same format as its companion line item-capital-cost estimate KE Report 78-62-RE.

25395 (ORO—5366-T8) **National waste terminal storage repository in a bedded salt formation for spent unreprocessed fuel: construction accounting manual.** (Kaiser Engineers, Oakland, CA (USA)). Dec 1978. Contract EY-77-C-05-5366. 167p. NTIS, PC A08/MF A01.

The preparation of a cost estimate for a program to construct a new or add-on waste storage facility is one of the major objectives of the conceptual design effort. It is essential that a construction accounting manual be developed for use in estimating (conceptual, Title 1 and working estimates), cost accounting and cost control purposes on a consistent basis throughout life of the project. In order to meet this objective, itemized cost estimates and cost accounting data must be in sufficient detail to assure the reliability of such cost estimates and cost data. A cost accounting manual for contractors involved in the project is set forth in this document. For the conceptual design cost estimate, the estimate will be prepared in accordance with this construction accounting manual and all future estimates will be prepared on this basis. When work starts under the project, cost data will be accumulated and reported in accordance with this manual to provide consistency between estimates and actual cost data for cost control programs.

25396 **In situ heating experiments in hard rock: their objectives and design.** Cook, N.G.W.; Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Materials Science and Engineering). pp 97-108 of Experiences de degagement de chaleur in situ dans les formations geologiques. Paris, France; OECD (1978).

From OECD seminar on in situ heating experiments in geological formations; Ludvika, Sweden (Sep 1978).

Of the many alternatives that are being considered for the disposal of nuclear wastes, deep underground burial is favored. The wealth of experience concerning the design and construction of underground excavations does not include the unique effects of heating excavations by radioactive decay, nor the issue of long-term isolation. The effects of heating are important in establishing the feasibility of this method of disposal and are essential for the design of an underground repository. Near-field phenomena around individual canisters can be studied by full-scale experiments, using electrical heaters. The thermal diffusivity of rock is so low that information concerning the interaction between full-scale heaters and of the effects of heating a large volume of rock cannot be measured in full-scale experiments lasting less than a few decades. To overcome this difficulty, a time-scaled heating experiment has been developed in which a reduction in linear scale is accompanied by an acceleration of the time scale to the second power. In this experiment, the linear scale is about a third, so that the time scale is about ten fold.

25397 (PNL—3162) **PATHS groundwater hydrologic model.** Nelson, R.W.; Schur, J.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 156p. NTIS, PC $10.50/MF $3.50.

A preliminary evaluation capability for two-dimensional groundwater pollution problems was developed as part of the Transport Modeling Task for the Waste Isolation Safety Assessment Program (WISAP). Our approach was to use the data limitations as a guide in setting the level of modeling detail. PATHS Groundwater Hydrologic Model is the first level (simplest) idealized hybrid analytical/numerical model for two-dimensional, saturated groundwater flow and single component transport; homogeneous geology. This document consists of the description of the PATHS groundwater hydrologic model. The preliminary evaluation capability prepared for WISAP, including the enhancements that were made because of the authors' experience using the earlier capability is described. Appendixes A through D supplement the report as follows: complete derivations of the background equations are provided in Appendix A. Appendix B is a comprehensive set of instructions for users of PATHS. It is written for users who have little or no experience with computers. Appendix C is for the programmer. It contains information on how input parameters are passed between programs in the system. It also contains program listings and test case listing. Appendix D is a definition of terms.

25398 (RHO-BWI-C—45) **Hydrologic bibliography of the Columbia River basalts in Washington with selected annotations.** Tanaka, H.; Wildrick, L.; Pearson, B. (Washington State Dept. of Ecology, Olympia (USA)). Aug 1979. Contract AC06-77RL01030. 118p. NTIS, PC A06/MF A01.

The objective of this compilation is to present a comprehensive listing of the published, unpublished, and open file references pertaining to the surface and subsurface hydrology of the Columbia River basalts within the State of Washington and is presented in support of Rockwell's hydrologic data compilation effort for the Basalt Waste Isolation Program. A comprehensive, annotated bibliography of the Pasco Basin (including the Hanford Site) hydrology has been prepared for Rockwell as part of the Pasco Basin hydrology studies. In order to avoid unnecessary duplication, no effort was made to include a complete list of bibliographic references on Hanford in this volume.

25399 (RHO-BWI-C—49) **Borehole plugging of man-made accesses to a basalt repository: a preliminary study.** Taylor, C.L.; Anttonen, G.J.; O'Rourke, J.E.; Niccum, M.R. (Woodward-Clyde Consultants, San Francisco, CA (USA)). Sep 1979. Contract AC06-RL7701030. 318p. NTIS, PC A14/MF A01.

This report describes the status of work currently in progress for the Basalt Borehole Plugging Program (BBPP). The primary objectives of the BBPP outlined in this report have been met during this first phase of work. These objectives included: (1) the preparation of a preliminary list of candidate plug materials; (2) a description of available machinery capable of placing candidate plug materials; and (3) the development of physical and geochemical testing programs to help evaluate the chemical stability and physical properties of candidate plug materials. The most significant finding from work to date is that given reasonable regulatory criteria, nothing has been identified which would prevent design of a plug system to seal man-made openings leading to a nuclear waste repository in Columbia River basalt for significantly long periods of time (on the order of thousands of years). Work accomplished to date indicates that this plug system can be designed using both natural and manufactured materials and can be emplaced with existing placement machinery and modifications of that machinery. The objectives of Task II are to conduct laboratory tests to evaluate the suitability of preferred candidate materials for plugging boreholes in the proposed repository, select plug system(s), initiate preconceptual machinery design for the placement of materials in plug system(s), and prepare a preliminary Task II report. As with Task I project organization, Task II is divided into subtasks that are identified by written subtask work summaries.

25400 (RHO-BWI-C—68) **Additions and corrections to the bibliography of geologic studies, Columbia Plateau (Columbia River Besalt) and adjacent Areas, in Idaho, 1980.** Strowd, W. (Idaho Bureau of Mines and Geology, Moscow (USA). Dept. of Lands). 1980. Contract AC02-77RL01030. 124p. NTIS, PC A06/MF A01.

This bibliography is an update to Idaho Bureau of Mines and Geology Open-File Report 78-6, Bibliography of Geological Studies, Columbia Plateau (Columbia River Basalt Group) and adjacent areas in Idaho (also known as Rockwell Hanford Operations' contractor report RHO-BWI-C-44). To keep the original document current, this additions and corrections report was prepared for the Basalt Waste Isolation Project of Rockwell Hanford Operations. This update is supplementary; therefore, references cited in the original document have not been included here. What is included are materials that have become available since the original publication and pertinent literature that had originally been overlooked. Accompany this updated bubliography are index maps that show locations of geologic studies and geochemical petrographic, remanent paleomagnetic, and radiometric age-dated sites within the Columbia River Basalt Group field within Idaho; also identified are archeological sites, test wells, mines, quarries, and other types of excavations. References on the index maps are keyed to the bibliography and cover the Spokane, Pullman, Hamilton, Grangeville, Elk City, Baker, Boise, and Jordan Valley Army Map Service two-degree quadrangles.

25401 (RHO-BWI-C—70) **Hydrothermal interactions of cesium and strontium phases from spent unreprocessed fuel with basalt phases and basalts.** Komarneni, S.; Scheetz, B.E.; McCarthy, G.J.; Coons, W.E. (Pennsylvania State Univ., University Park (USA); Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Mar 1980. Contract AC06-77RL01030. 39p. NTIS, PC A03/MF A01.

This investigation is a segment of an extensive research program aimed at investigating the feasibility of long-term, subsurface storage of commercial nuclear waste. Specifically, it is anticipated that the waste will be housed in a repository mined from the basalt formations which lie beneath the Hanford Site. The elements monitored during the present experiments were Cs and Sr. These two elements represent significant biohazards if released from a repository and are the major heat producing radionuclides present in commercial radioactive waste. Several Cs phases and/or solutions were reacted with either isolated basalt phases or bulk-rock basalt, and the resulting solids and solutions were analyzed. The hydrothermal reactivity of $SrZrO_3$, which is believed to be a probable host for Sr in SFE was investigated. While so far no evidence exists which indicates that Sr is present in a water soluble phase in spent fuel elements (SFE), detailed investigation of a potential hazard is warranted. This investigation has determined that some Cs compounds likely to be stable components of spent fuel (i.e., CsOH, Cs_2MoO_4, $Cs_2U_2O_7$) have significant hydrothermal solubilities. These solubilities are greatly decreased in the presence of basalt and/or basalt minerals. The decrease in the amount of Cs in solution results from reactions which form pollucite and/or $CsAlSiO_4$, with the production of pollucite exceeding that of $CsAlSiO_4$. Dissolution of β-$Cs_2U_2O_7$ implies solubilizing a uranium species to an undetermined extent. The production of schoepite ($UO_3.3H_2O$) during some experiments containing basalt phases, indicates a tendency to oxidize U^{4+} to U^{6+}. When diopside (nominally $CaMgSi_2O_6$) and β-$Cs_2U_2O_7$ were hydrothermally reacted, at 300°C both UO_2 and $UO_3.3H_2O$ were produced. Results of experiments on $SrZrO_3$ show it to be an unreactive phase. Interpretations of the hydrothermal phase relations of $SrZrO_3$ in the presence of basalt are obscured by its low solubility.

25402 (RHO-BWI-CD—42) **Research borehole drilling activity for boreholes DH-18, DH-19, DC-12, DC-13, DC-14, DC-15, and deepening of existing borehole DC-7.** (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Sep 1979. Contract AC06-77RL01030. 27p. NTIS, PC A03/MF A01.

This report is an environmental evaluation of the impacts of proposed borehole drilling activities at the Hanford Site, northwest of Richland, Washington. The proposed action is to drill six research boreholes ranging in depth from 137 to 1372 meters (m) [250 to 4500 +- feet (ft)]. In addition, an existing borehole (DC-7) will be extended from 1249 to 1524 m (4099 to 5000 +- ft). The purpose of the US Department of Energy's (DOE) borehole drilling activities is to collect data on in situ rock formations that are considered potentialy suitable for nuclear waste repositories. The technical program efforts necessary to identify and qualify specific underground waste facility sites in candidate rock formations include geologic and hydrologic studies (seismicity and tectonics, rock structure and stratigraphy, lithology, etc.). Borehole drilling is an integral part of the geological studies and is essential to a thorough understanding of potentially suitable geologic formations. The purpose of the proposed drilling activities is to obtain data for evaluating Columbia River basalts that are being evaluated by the National Waste Terminal Storage (NWTS) Program to determine their suitability potential for nuclear waste repositories. Unavoidable impact to the environment is limited primarily to the clearing of land needed for access and drilling operations. Considerations exercised during site preparation, drilling, and subsequent site restoration will limit modification of the natural environment to the minimum required for accomplishment of test objectives.

25403 (RHO-BWI-LD—23) **Functions of an engineered barrier system for a nuclear waste repository in basalt.** Coons, W.E.; Moore, E.L.; Smith, M.J.; Kaser, J.D. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Jan 1980. Contract AC06-77RL01030. 35p. NTIS, PC A03/MF A01.

Defined in this document are the functions of components selected for an engineered barrier system for a nuclear waste repository in basalt. The definitions provide a focal point for barrier material research and development by delineating the purpose and operative lifetime of each component of the engineered system. A five-component system (comprised of waste form, canister, buffer, overpack, and tailored backfill) is discussed in terms of effective operation throughout the course of repository history, recognizing that the emplacement environment changes with time. While components of the system are mutually supporting, redundancy is provided by subsystems of physical and chemical barriers which act in concert with the geology to provide a formidable barrier to transport of hazardous materials to the biosphere. The operating philosophy of the conceptual engineered barrier system is clarified by examples pertinent to storage in basalt, and a technical approach to barrier design and material selection is proposed. A method for system validation and qualification is also included which considers performance criteria proposed by external agencies in conjunction with site-specific models and risk assessment to define acceptable levels of system performance.

25404 (RHO-CD—132(Rev.5)) **Technical program plan, Basalt Waste Isolation Project.** (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Dec 1979. Contract AC06-77RL01030. 128p. NTIS, PC A07/MF A01.

The Basalt Waste Isolation Project (BWIP) program as administered by the DOE's Richland Operations Office and Rockwell Hanford Operations is described. The objectives, scope and scientific technologies are discussed. The work breakdown structure of the project includes: project management and support, systems integration, geosciences, hydrology, engineered barriers, test facility design

and construction, engineering testing, repository studies, and schedules. The budget of the program including operating and capital cost control is also included. (DC)

25405 (RHO-LD—98) **Leaching technique for studying actinide-contaminated Hanford sediments.** Gallagher, S.A. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Oct 1979. Contract AC06-77RL01030. 23p. NTIS, PC A02/MF A01.

For more than 30 years, liquid wastes containing low concentrations of actinides from chemical processing plants have been disposed directly to the ground of the Hanford Site via trenches. These liquid wastes contained trace amounts of the actinides plutonium and americium. Because these elements are biologically harmful to man, they must remain isolated from the biosphere. Therefore, the ability of the sediments to provide this protection must be studied. Assessment of the stability of the actinides in the trench sediments is necessary to evaluate the need for long-term radionuclide stabilization measures. Three possible mechanisms exist for the transport of plutonium and americium in the sediments. These are leaching, diffusion, and particulate transport. Compared to particulate transport, diffusion is generally a slow method of transport, and leaching can occur at the same time as solutions percolate through the sediments. For this reason, three leaching techniques were reviewed, and small column leaching was chosen as the best method for assessing the stability of the actinides in contaminated sediments. This method most closely approximates natural conditions and employs a realistic solution/soil ratio. Procedures are given for implementing this technique. Both the stability and the chemical form of plutonium will be studied. Data will be input to the modeling of transport of radionuclides in sediments and also input to the ongoing assessment of waste sites.

25406 (SAND—79-0275) **Basic data report for drillhole WIPP 18 (Waste Isolation Pilot Plant - WIPP).** (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76-DP00789. 73p. NTIS, PC A04/MF A01.

WIPP 18 is an exploratory borehole whose objective is to determine the nature of the near-surface formations after seismic information indicated a possible fault. The borehole is located in section 20, T.22S., R.31E., in eastern Eddy County, New Mexico, and was drilled between March 14 and 30, 1978. The hole was drilled to a depth of 1060 feet and encountered, from top to bottom, surficial Holocene deposits (5', including artificial fill for drill pad), the Mescalero caliche (4'), the Santa Rosa Sandstone (129'), the Dewey Lake Red Beds (475'), the Rustler Formation (315'), and the upper portion of the Salado Formation (132'). Cuttings were collected at 10-foot intervals. A suite of geophysical logs was run to measure acoustic velocities, density, and radioactivity. On the basis of comparison with other geologic sections drilled in the area, the WIPP 18 section is a normal stratigraphic sequence and it does not show structural disruption. The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes. The WIPP will also provide facilities to research interactions between high-level waste and salt.

25407 (SAND—79-0277) **Basic data report for drillhole WIPP 21 (Waste Isolation Pilot Plant - WIPP).** (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 62p. NTIS, PC A04/MF A01.

WIPP 21 is an exploratory borehole whose objective is to determine the nature of the near-surface formations after seismic information indicated a possible fault. The borehole is located in section 20, T.22S., R.31E., in eastern Eddy County, New Mexico, and was drilled between May 24 and 26, 1978. The hole was drilled to a depth of 1046 feet and encountered, from top to bottom, surficial Holocene deposits (6', including artificial fill for drill pad), the Mescalero caliche (6'), the Santa Rosa Sandstone (34'), the Dewey Lake Red Beds (487'), the Rustler Formation (308'), and the upper portion of the Salado Formation (178'). Cuttings were collected at 10-foot intervals. A suite of goephysical logs was run to measure acoustic velocities, density, and radioactivity. On the basis of comparison with other geologic sections drilled in the area, the WIPP 21 section is a normal stratigraphic sequence and it does not show structural disruption. The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes. The WIPP will also provide facilities to research interactions between high-level waste and salt.

25408 (SAND—79-1199) **Heated mine room and pillar secondary creep response.** Tillerson, J.R.; Dawson, P.R. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP 00789. 47p. NTIS, PC A03/MF A01.

Heated salt mine room and pillar simulations have been performed to provide information regarding parameters affecting room closure rates to designers of radioactive waste isolation facilities. A coupled secondary creep and heat transfer formulation with large strain capabilities was used to assess the effects of variations in creep law parameters, thermal properties, imposed boundary conditions, temporal integration, and meshing resolution on room closure rates. Results indicate that the greatest effect results from variations in parameters appearing in the creep constitutive equation.

25409 (SAND—79-1265) **Preliminary one-dimensional thermal analysis of waste emplacement in tuffs.** Bulmer, B.M.; Lappin, A.R. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 31p. NTIS, PC A03/MF A01.

One-dimensional calculations of near-field temperatures resulting from waste emplacement in a multiple-layered tuff stratigraphy are presented. Results indicate a marked sensitivity of peak temperatures to assignment of in-situ fluid pressure, geothermal-heat flux, waste type, and location of waste relative to a specific stratigraphic discontinuity. Under the criterion that allowable initial-power densities are limited by the occurrence of boiling at a distance of 10 m from emplaced waste, allowable power densities are calculated to range up to 150 kW/acre or more, depending upon geothermal heat flux and waste type.

25410 (SAND—79-2328C) **Creep of ocean sediments resulting from the isolation of radioactive wastes.** Dawson, P.R.; Chavez, P.F.; Lipkin, J.; Silva, A.J. (Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering; Rhode Island Univ., Kingston (USA). Dept. of Ocean Engineering). 1980. Contract AC04-76DP00789. 39p. (CONF-800420—4). NTIS, PC A03/MF A01.

From 2. international ocean disposal symposium; Woods Hole, MA, USA (15 Apr 1980).

Predictive models for the creep of deep ocean sediments resulting from the disposal of radioactive wastes are presented and preliminary observations of a program for evaluation of creep constitutive equation parameters are discussed. The models are used to provide calculated response of sediments under waste disposal conditions.

25411 (SAND—79-7111) **Thermomechanical response of WIPP repositories.** Maxwell, D.E.; Wahi, K.K.; Dial, B. (Science Applications, Inc., San Leandro, CA (USA); Civil Systems, Inc., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 77p. NTIS, PC A05/MF A01.

Coarsely zoned STEALTH 2D calculations were used to investigate two candidate WIPP repositories. The grid was designed for one hundred thousand years of response with modest computing costs. As a result, the early time mechanical response was compromised by non-real oscillations that could not be damped completely before a few thousand years. In spite of these oscillations, it was possible to see that the dominant effects of stress and strain peaked between one and two thousand years, at the time of maximum heat in the site. This time corresponded to the condition that the surface heat loss rate balanced the heat generation rate. Though the creep strains were quite small, a large volume of salt was involved and the effects were significant. The peak surface uplift of 75HLW was increased by about 25% due to creep. However, the deviatoric stress relaxation due to creep produced large changes in the stress fields. The Rustler layer survived reasonable failure criterion for the 75HLW case with creep, and failed both in tension and shear, according to these same criterion, when the calculation was repeated without creep. The deviatoric stress fields, with and without salt creep, concentrated near the repository as expected and also in the Rustler layer due to its relatively high Young's modulus compared to the neighboring layers. Since the time of interest is so much smaller than the 100,000 years this calculation was designed to examine, it is possible to model the WIPP stratigraphy in much more detail and still be able to calculate the response for the time of interest. A finer zoned calculation of the response of the WIPP stratigraphy to a repository similar to the 75 K watt/acre repository is modeled in this report. In this calculation the Rustler formation is modeled as a five layered formation using material properties derived from data taken at the Nome site.

25412 (SAND—80-0087) **Creep curves and fitting parameters for southeastern New Mexico bedded salt.** Herrmann, W.; Wawersik, W.R.; Lauson, H.S. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 171p. NTIS, PC A08/MF A01.

Existing experimental data for 68 separate creep tests on rock salt from the Salado formation of SE New Mexico have been analyzed. The experimental conditions covered an intermediate temperature range from 22°C to 200°C, and shear stresses from 1000 psi (7 MPa) to 6000 psi (31 MPa). Most tests exhibited both transient and steady-state creep. Data for individual tests have been fitted both to an exponential transient creep law expected to hold at high temperaures ($> 200°C$) and a logarithmic transient creep law expected to hold at low temperature ($< 50°C$). A few tests also exhibited accelerating creep, and these were fitted with an exponential creep law which included an accelerating term. The exponential and logarithmic fits yielded steady-state creep rates which were in good agreement with each other. Low temperature and low stress tests were fitted much better by the logarithmic creep law. At higher

tempertures both logarithmic and exponential creep laws were found to fit equally well. Tabulations of fitting parameters and plots of the experimental data and fitted creep curves are presented for each experiment, for use in further analysis.

25413 (SAND—80-0459) **Downhole television (DHTV) applications in borehole plugging.** Christensen, C.L.; Statler, R.D.; Peterson, E.W. (Systems, Science and Software, La Jolla, CA (USA)). May 1980. Contract AC04-76DP00789. 32p. NTIS, PC A03/MF A01.

The Borehole Plugging (BHP) Program is a part of the Sandia experimental program to support the Waste Isolation Pilot Plant (WIPP). The Sandia BHP program is an Office of Nuclear Waste Isolation (ONWI)-funded program designed to provide inputs to the generic plugging program while simultaneously acquiring WIPP-specific data. For this reason a close liaison is maintained between the Sandia WIPP project and the ONWI generic program. Useful technology developed within the Sandia BHP to support WIPP is made available and considered for further development and application to the generic Borehole Plugging and Repository Sealing Program at ONWI. The purpose of this report is to illustrate the usefulness of downhole television (DHTV) observations of a borehole to plan plugging operations. An indication of the wellbore conditions observed is provided. The equipment and setup procedure used in the evaluation of AEC-7 for the Bell Canyon test series are illustrated. A sequence of pictures at various depths as the DHTV rig is lowered through the wellbore is presented. Sample photographs taken with both dry and underwater lamps for illumination are included. The caliper logs for the same depth are included for comparison. General comments are provided on the illustrations.

25414 (SAND—80-0558) **Analysis of steady state creep of southeastern New Mexico bedded salt.** Herrmann, W.; Wawersik, W.R.; Lauson, H.S. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 41p. NTIS, PC A03/MF A01.

Steady state creep rates have been obtained from a large suite of existing experimental creep data relating to bedded rock salt from the Salado formation of S.E. New Mexico. Experimental conditions covered an intermediate temperature range from 22°C to 200°C, and shear stresses from 1000 psi (7 MPa) to 6000 psi (31 MPa). An expression, based on a single diffusion controlled dislocation climb mechanism, has been found to fit the observed dependence of steady state creep rate on shear stress and temperature, yielding an activation energy of 12 kcal/mole (50 kJ/mole) and a stress exponent of 4.9. Multiple regression analysis revealed a dependence on stratigraphy, but no statistically significant dependence on pressure of specimen size. No consistent dilatancy or compaction associated with steady state creep was found, although some individual specimens dilated or compacted during creep. The steady state creep data were found to agree very well with creep data for both bedded and dome salt from a variety of other locations.

25415 (UCID—18662) **Annular air space effects on nuclear waste canister temperatures in a deep geologic waste repository.** Lowry, W.E.; Cheung, H.; Davis, B.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 May 1980. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

Air spaces in a deep geologic repository for nuclear high level waste will have an important effect on the long-term performance of the waste package. The important temperature effects of an annular air gap surrounding a high level waste canister are determined through 3-D numerical modeling. Air gap properties and parameters specifically analyzed and presented are the air gap size, surfaces emissivity, presence of a sleeve, and initial thermal power generation rate; particular emphasis was placed on determining the effect of these variables have on the canister surface temperature. Finally a discussion based on modeling results is presented which specifically relates the results to NRC regulatory considerations.

25416 (UCRL—15180) **Development of an inter-layer solute transport algorithm for SOLTR computer program. Part 1. The algorithm.** Miller, I.; Roman, K. (Golder Associates, Inc., Kirkland, WA (USA)). Dec 1979. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

In order to perform studies of the influence of regional groundwater flow systems on the long-term performance of potential high-level nuclear waste repositories, it was determined that an adequate computer model would have to consider the full three-dimensional flow system. Golder Associates' SOLTR code, while three-dimensional, has an overly simple algorithm for simulating the passage of radionuclides from one aquifier to another above or below it. Part 1 of this report describes the algorithm developed to provide SOLTR with an improved capability for simulating interaquifer transport.

25417 (UCRL—15235) **Spatial patterns of radiological dose from wells drilled near nuclear waste repositories.** (Analytic Sciences Corp., Reading, MA (USA)). 31 Mar 1980. Contract W-7405-ENG-48. 63p. NTIS, PC A04/MF A01.

This report describes methodology for assessing the spatial patterns of radiological dose to man from wells drilled near nuclear waste repositories. Descriptions of the various categories of water wells and a model of a typical aquifer are presented. The equation governing the one-dimensional flow of waste in groundwater through porous media to a well is discussed. This is followed by development of a method for constructing lines of constant dose from a well located randomly in the plane of the aquifer. An area of hazard, in which the dose to man from a well exceeds a given statuatory or recommended limit, is then defined within this dose pattern. This technique is then used to compute dose and hazard profiles for wells adjacent to a repository located in either impermeable or permeable bedded salt. The repository and geologic parameters employed in this example are taken from a Lawrence Livermore Laboratory report for which this report serves as a supporting document. Scenarios with impermeable salt involve waste entering the repository through the shaft/tunnel fracture zone and exiting through a single additional flaw (borehole). Permeable-salt scenarios involve waste escaping from the repsitory through a borehole and via interstitial flow. Calculations are performed assuming both a single-layer (sandstone) aquifer and a double-layer (sandstone/shale) aquifer in the strate overlying the repository. Results indicate a time-varying area of hazard from well drilling, whose size depends on the permeability of the salt, the regional hydrology, and the surface ecosystem assumed in the potential hazard calculations.

25418 (UCRL—15236) **Bedded-salt repository analysis. Final report.** Guiffre, M.S.; Kaplan, M.F.; Ensminger, D.A.; Oston, S.G.; Nalbandian, J.Y. (Analytic Sciences Corp., Reading, MA (USA)). 31 Mar 1980. Contract W-7405-ENG-48. 214p. NTIS, PC A10/MF A01.

This report contains a description of an analysis of generic nuclear waste repository in bedded salt. This analysis was performed by TASC for inclusion in a major Lawrence Livermore Laboratory report to NRC; this report therefore should be viewed as providing more complete and detailed information about this analysis than was possible to include in the LLL report. The analysis is performed with the NUTRAN computer codes which are described in the report. The model to be analyzed is defined, and the results of a series of possible waste migration scenarios are presented. Several of these scenarios are used as the basis for a sensitivity analysis, and an uncertainty analysis utilizing Monte Carlo techniques is also performed. A new method for defining the consequences to users of a well drilled near the repository is also described, and results are presented based on two of the waste migration scenarios.

25419 (UCRL—15238) **Deep geological isolation of nuclear waste: numerical modeling of repository scale hydrology.** Dettinger, M.D. (Camp Dresser and McKee, Boston, MA (USA)). Apr 1980. Contract W-7405-ENG-48. 79p. NTIS, PC A05/MF A01.

The Scope of Work undertaken covers three main tasks, described as follows: (Task 1) CDM provided consulting services to the University on modeling aspects of the study having to do with transport processes involving the local groundwater system near the repository and the flow of fluids and vapors through the various porous media making up the repository system. (Task 2) CDM reviewed literature related to repository design, concentrating on effects of the repository geometry, location and other design factors on the flow of fluids within the repository boundaries, drainage from the repository structure, and the eventual transport of radionucldies away from the repository site. (Task 3) CDM, in a joint effort with LLL personnel, identified generic boundary and initial conditions, identified processes to be modeled, and recommended a modeling approach with suggestions for appropriate simplifications and approximations to the problem and identifiying important parameters necessary to model the processes. This report consists of two chapters and an appendix. The first chapter (Chapter III of the LLL report) presents a detailed description and discussion of the modeling approach developed in this project, its merits and weaknesses, and a brief review of the difficulties anticipated in implementing the approach. The second chapter (Chapter IV of the LLL report) presents a summary of a survey of researchers in the field of repository performance analysis and a discussion of that survey in light of the proposed modeling approach. The appendix is a review of the important physical processes involved in the potential hydrologic transport of radionuclides through, around and away from deep geologic nuclear waste repositories.

25420 (UCRL—83728) **Spent fuel handling system for a geologic storage test at the Nevada Test Site.** Duncan, J.E.; House, P.A.; Wright, G.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1980. Contract W-7405-ENG-48. 20p. (CONF-800607—54). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The Lawrence Livermore Laboratory is conducting a test of the geologic storage of encapsulated spent commercial reactor fuel assemblies in a granitic rock at the Nevada Test Site. The test, known as the Spent Fuel Test-Climax (SFT-C), is sponsored by the

US Department of Energy, Nevada Operations Office. Eleven pressurized-water-reactor spent fuel assemblies are stored retrievably for three to five years in a linear array in the Climax stock at a depth of 420 m.

25421 (USGS-OFR—80-466) **Resistivity sounding investigation by the Schlumberger method in the Syncline Ridge area, Nevada Test Site, Nevada.** Anderson, L.A.; Bisdorf, R.J.; Schoenthaler, D.R. (Geological Survey, Denver, CO (USA)). 1980. Contract EW-78-A-08-1543. 67p. NTIS, PC A04/MF A01.

A resistivity survey was made in the north-central sector of the Nevada Test Site (NTS) as part of an extensive search for suitable geologic environments to be used as repositories for radioactive waste products. The area of interest, identified herein as Syncline Ridge after a locally prominent structural feature, lies within the Tippipah Spring Quadrangle. The surficial geology generalized from Orkild (1963), mapped and inferred faults, resistivity sounding sites, borehole emplacements, and alinements of resistivity cross sections compiled from the interpreted sounding data are included. The intent of the survey was to determine the horizontal continuity and thickness of unit J of the Eleana Formation. Ten distinct lithologic units make up the Eleana Formation but only units G, H, I, and J of Mississippian age are found in the Syncline Ridge area. Because of its relative importance in this survey, unit J is shown as a separate entity, whereas the G, H, and I units have been grouped under the general heading of Eleana Formation.

25422 **Full-scale and time-scale heating experiments at Stripa: preliminary results.** Cook, N.G.W.; Hood, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Materials Science and Engineering). pp 147-159 of Experiences de degagement de chaleur in situ dans les formations geologiques. Paris, France; OECD (1978).

From OECD seminar on in situ heating experiments in geological formations; Ludvika, Sweden (Sep 1978).

Two full-scale heating experiments and a time-scale heating experiment have recently been started in granite 340 meters below surface. The purpose of the full-scale heating experiments is to assess the near-field effects of thermal loading for the design of an underground repository of nuclear wastes. That of the time-scale heating experiments is to obtain field data of the interaction between heaters and its effect on the rock mass during a period of about two years, which corresponds to about twenty years of full-scale operation. Geological features of the rock around each experiment have been mapped carefully, and temperatures, stresses and displacements induced in the rock by heating have been calculated in advance of the experiments. Some 800 different measurements are recorded at frequent intervals by a computer system situated underground. These data can be compared at any time with predictions made earlier on video display units underground.

25423 **Approach to the fracture hydrology at Stripa: preliminary results.** Gale, J.E. (Waterloo Univ., Ontario (Canada)); Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Materials Science and Engineering). pp 161-176 of Experiences de degagement de chaleur in situ dans les formations geologiques. Paris, France; OECD (1978).

From OECD seminar on in situ heating experiments in geological formations; Ludvika, Sweden (Sep 1978).

There are two main problems associated with the concept of geologic storage of radioactive waste in fractured crystalline rock. These problems are the thermomechanical effects of the heat generated by the waste and the potential for transport of radioactive materials by the groundwater system. In both problems, fractures play a dominant role. An assessment of the hydraulic and mechanical characteristics of fractured rocks requires a careful series of laboratory and field investigations. A good example of the complexity of the problem is illustrated by the field studies in a fractured granite that are currently underway in an abandoned iron-ore mine at Stripa, Sweden. Much information is being gathered from an extensive series of boreholes and fracture maps. The approach being taken to integrate these data into an analysis of the fracture hydrology is reviewed and preliminary results from the hydrology program are presented.

25424 **Design, installation, and operation of heater tests in dome salt.** van Sambeek, L.L. (RE/SPEC, Inc., Rapid City, SD (USA)); Heck, J.L. (Oak Ridge National Lab., TN (USA)). pp 71-82 of Experiences de degagement de chaleur in situ dans les formations geologiques. Paris, France; OECD (1978).

From OECD seminar on in situ heating experiments in geological formations; Ludvika, Sweden (Sep 1978).

Three in situ heater tests are currently in the heating phase in the Avery Island dome salt mine. Three power levels are being used for the three heater tests. The three heater tests include the use of protective steel sleeves, wherein the heater resides at depth. Data being gathered includes both scientific and engineering data concerning salt properties determination, corrosion potential, retrievability, and data for comparison of measured and predicted responses. The heating phase is only some 100 days into its duration, thus only limited data can be presented.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25228, 25345, 25363, 25402, 25405, 25416, 25417, 25445, 26309, 26313, 26315

25425 (DOE/EV—0005/20) **Formerly utilized MED/AEC sites remedial action program. Radiological survey of the Middlesex Municipal Landfill, Middlesex, New Jersey. Final report.** Leggett, R.W.; Cottrell, W.D.; Goldsmith, W.A.; Christian, D.J.; Haywood, F.F.; Wagner, E.B.; Crawford, D.J.; Doane, R.W.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 98p. NTIS, PC A05/MF A01.

A radiological survey was conducted at the Middlesex Municipal Landfill in Middlesex, New Jersey. In 1948, dirt contaminated with pitchblende ores was brought to this site from a former ore sampling plant in Middlesex. This survey was conducted in order to characterize the present radiological condition of the site and to determine the extent to which contamination is being transported from the site by natural means such as by drainage. The survey included measurement of (1) radionuclide concentrations in surface and subsurface soil on the site; (2) radionuclide concentrations in surface and subsurface water on the site and in Bound Brook; (3) beta-gamma dose rates and external gamma radiation levels on and near the site; and (4) the rate of ^{222}Rn emanation from the soil on the site. It was found that most of the contamination on the site is in the top 14 ft of soil; however, there is little contamination of surface soil on the site. Average radon emanation rates, average external gamma radiation levels, and average beta-gamma dose rates on the site do not appear to be significantly higher than background levels. Furthermore, radionuclide concentrations in water taken from Bound Brook near the site were far below guide values stated in federal guidelines.

25426 (LA—8309-PR) **Research and development related to the Nevada nuclear waste storage investigations. Progress report, October 1-December 31, 1979.** Crowe, B.M. (comp.). (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 22p. NTIS, PC A02/MF A01.

Batch sorption measurements in air with Sr, Cs, Ba, Ce, and Eu were conducted with four additional tuff samples. Additional results for sorption of Pu and Am are presented. Results for sorption of Tc, Sr, Cs, Ba, Ce, Eu, and U(VI) are given and compared with results in air. Migration rate studies with crushed tuff are continuing, and, in some cases, uniform peakless elution is being observed. Methods for studying the migration rate of uranium (VI) are being developed. Nuclides are being infiltrated into various types of solid cores for study after sectioning. Microautoradiographic examination of crushed tuff samples used in the batch determinations indicate that large species of americium are sorbed. Methods for determination of iron(II) in both rocks and waters are described. The probability of disruption of a repository site at Yucca Mountain by future volcanic activity is bracketed by the range 10^{-8} to 10^{-10}/y. Partitioning functions for selected elements in plagioclase and olivine phenocrysts were examined for estimates of near-liquidus temperatures of representative melt compositions of the basalts of Crater Flat. Higher temperature estimates were calculated for glomeroperphyritic clots in the oldest basalts of Crater Flat.

25427 (RHO-BWI-C—65) **Characterization of the physical parameters and sampling procedure of a modified rocking autoclave apparatus.** Scheetz, B.E. (Pennsylvania State Univ., University Park (USA)). Apr 1980. Contract AC06-77RL01030. 18p. NTIS, PC A02/MF A01.

Purpose of the apparatus is to investigate the stability of several candidate radwaste forms under simulated deep geological disposal. (DLC)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25371, 25423, 26416, 26417

25428 (LA-UR—80-926) **LASL experience in decontamination of the environment.** Ahlquist, A.J. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 19p. (CONF-791234—2). Dep. NTIS, PC A02/MF A01.

From Environmental decontamination workshop; Oak Ridge, TN, USA (4 Dec 1979).

Since 1972 the Los Alamos Scientific Laboratory (LASL) has been actively involved in land area surveys for radioactive contamination and has gained considerable experience in cleanup of lands considered to have unacceptable levels of radioactive contamination.

This paper describes our experience and means of arriving at recommendations for ALARA.

25429 (PNL—3340) **Estimated airborne release of plutonium from the Exxon Nuclear Mixed Oxide Fuel Plant at Richland, Washington as a result of postulated damage from severe wind and earthquake hazard.** Mishima, J.; Schwendiman, L.C.; Ayer, J.E.; Owzarski, E.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1980. Contract AC06-76RL01830. 45p. NTIS, PC A03/MF A01.

The potential airborne releases of plutonium from postulated damage sustained by the Exxon Nuclear Company's Mixed Oxide Fabrication Plant at Richland, Washington, as a result of various levels of wind and earthquake hazard, are estimated. The releases are based on damage scenarios that range up to 250 mph for wind hazard and in excess of 1.0 g ground acceleration for seismic hazard, which were developed by other specialists. The approaches and factors used to estimate the releases (inventories of dispersible materials at risk, damage levels and ratios, fractional airborne releases of dispersible materials under stress, atmosphere exchange rates, and source term ranges) are discussed. Release estimates range from less than 10^{-7} g to greater than 14 g of plutonium over a four-day period.

25430 (SAND—79-7093) **State policies and requirements for management of uranium mining and milling in New Mexico. Volume V. State policy needs for community impact assistance.** Vandevender, S.G. (Resource Communities, Inc., Santa Fe, NM (USA)). Apr 1980. Contract AC04-76DP00789. 109p. NTIS, PC A06/MF A01.

The report contained in this volume describes a program for management of the community impacts resulting from the growth of uranium mining and milling in New Mexico. The report, submitted to Sandia Laboratories by the New Mexico Department of Energy and Minerals, is reproduced without modification. The state recommends that federal funding and assistance be provided to implement a growth management program comprised of these seven components: (1) an early warning system, (2) a community planning and technical assistance capability, (3) flexible financing, (4) a growth monitoring system, (5) manpower training, (6) economic diversification planning, and (7) new technology testing.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 25885

25431 (AGNS—35900-CONF-72) **Measuring process solutions in a reprocessing plant to 0.1%.** Crawford, J.M.; Ehinger, M.H.; Ellis, J.H. (Allied-General Nuclear Services, Barnwell, SC (USA)). Mar 1980. Contract ET-78-C-09-1040. 10p. (CONF-800315—15). Dep. NTIS, PC A02/MF A01.

From 2. symposium of the European Safeguards Research and Development Association; Edinburgh, UK (26 Mar 1980).

Measurement of SNM in reprocessing plant solutions involves two major problems; measurement of bulk solution quantities and analysis of highly radioactive samples. It has been shown at the BNFP that bulk measurements can be made routinely under operating conditions to less than 0.1% total uncertainty. Two specific advances in measurement technology have been largely responsible for this improved performance. The quartz bourdon tube electromanometer replaces the fluid manometer for differential pressure measurements. The vibrating tube densimeter provides accurate measurement of density in lab samples. These instruments, coupled with a rigorous measurement and quality control procedures, are the means to achieve better than 0.1% performance.

25432 (BNL—27660) **Laser surveillance system for spent fuel.** Fiarman, S.; Zucker, M.S.; Bieber, A.M. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 22p. (CONF-800315—20). NTIS, PC A02/MF A01.

From 2. symposium of the European Safeguards Research and Development Association; Edinburgh, UK (26 Mar 1980).

A laser surveillance system installed at spent fuel storage pools (SFSP's) will provide the safeguard inspector with specific knowledge of spent fuel movement that cannot be obtained with current surveillance systems. The laser system will allow for the division of the pool's spent fuel inventory into two populations - those assemblies which have been moved and those which haven't - which is essential for maximizing the efficiency and effectiveness of the inspection effort. We have designed, constructed, and tested a full size laser system operating in air and have used an array of 6 zircaloy BWR tubes to simulate an assembly. The reflective signal from the zircaloy rods is a strong function of position of the assembly, but in all cases is easily discernable from the reference scan of the background with no assembly. A design for a SFSP laser surveillance system incorporating laser ranging is discussed. 10 figures.

25433 (BNL—27664) **Assay of low-enriched uranium using spontaneous fission neutrons.** Zucker, M.S.; Fainberg, A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 32p. (CONF-800315—19). NTIS, PC A03/MF A01.

From 2. symposium of the European Safeguards Research and Development Association; Edinburgh, UK (26 Mar 1980).

Low-enriched uranium oxide in bulk containers can be assayed for safeguards purposes, using the neutrons from spontaneous fission of ^{238}U as a signature, to complement enrichment and mass measurement. The penetrability of the fast fission neutrons allows the inner portion of bulk samples to register. The measurement may also be useful for measuring moisture content, of significance in process control. The apparatus used can be the same as for neutron correlation counting for Pu assay. The neutron multiplication observed in ^{238}U is of intrinsic interest.

25434 (LA—8042(Vol.1)) **Materials management in an internationally safeguarded fuels reprocessing plant.** Hakkila, E.A.; Cobb, D.D.; Dayem, H.A.; Dietz, R.J.; Kern, E.A.; Markin, J.T.; Shipley, J.P.; Barnes, J.W.; Scheinman, L. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 7p. NTIS, PC A02/MF A01.

The first volume of this report summarizes the results and conclusions for this study of conventional and advanced nuclear materials accounting systems applicable for both large (1500 MTHM/y) and small (210 MTHM/y) spent-fuel reprocessing facilities subject to international verification.

25435 (LA—8042(Vol.2)) **Materials management in an internationally safeguarded fuels reprocessing plant.** Hakkila, E.A.; Cobb, D.D.; Dayem, H.A.; Dietz, R.J.; Kern, E.A.; Markin, J.T.; Shipley, J.P.; Barnes, J.W.; Scheinman, L. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 152p. NTIS, PC A08/MF A01.

The second volume describes the requirements and functions of materials measurement and accounting systems (MMAS) and conceptual designs for an MMAS incorporating both conventional and near-real-time (dynamic) measurement and accounting techniques. Effectiveness evaluations, based on recently developed modeling, simulation, and analysis procedures, show that conventional accountability can meet IAEA goal quantities and detection times in these reference facilities only for low-enriched uranium. Dynamic materials accounting may meet IAEA goals for detecting the abrupt (1-3 weeks) diversion of 8 kg of plutonium. Current materials accounting techniques probably cannot meet the 1-y protracted-diversion goal of 8 kg for plutonium.

25436 (LA—8042(Vol.3)) **Materials management in an internationally safeguarded fuels reprocessing plant.** Hakkila, E.A.; Baker, A.L.; Cobb, D.D. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 273p. NTIS, PC A12/MF A01.

The following appendices are included: aqueous reprocessing and conversion technology, reference facilities, process design and operating features relevant to materials accounting, operator's safeguards system structure, design principles of dynamic materials accounting systems, modeling and simulation approach, optimization of measurement control, aspects of international verification problem, security and reliability of materials measurement and accounting system, estimation of in-process inventory in solvent-extraction contactors, conventional measurement techniques, near-real-time measurement techniques, isotopic correlation techniques, instrumentation available to IAEA inspectors, and integration of materials accounting and containment and surveillance. (DLC)

25437 (LA—8182-M) **DYMAC communications system.** Lindsey, K.A. (Los Alamos Scientific Lab., NM (USA)). Jan 1980. Contract W-7405-ENG-36. 130p. Dep. NTIS, PC A07/MF A01.

The DYMAC Communications System is part of a nuclear safeguards system called DYMAC - short for DYnamic Materials ACcountability - that gathers accountability information at the Los Alamos Scientific Laboratory (LASL) Plutonium Processing Facility. The communications system handles transmissions between data-entry terminals and nondestructive assay (NDA) instruments located in the facility, and a computer located in an adjacent building. System design emphasizes reliability rather than high speed to ensure the integrity of data transmissions. This manual is directed toward the person responsible for maintaining the DYMAC Communication System. It describes the components that make up the communications network, explains how they operate, and gives detailed information about all of the connections. Many of the system components are commercially available; some have been modified at LASL for DYMAC purposes; others were designed and fabricated at LASL. This manual provides circuit diagrams for all of the LASL modifications and LASL-fabricated equipment. In addition, it provides a series of procedures for tracing cables, reconfiguring various parts of the system, testing data transmissions, and troubleshooting malfunctions.

25438 (LA—8241-PR) **Nuclear safeguards research and development. Program status report, October-December 1979.** Keepin, G.R. (ed.). (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 61p. NTIS, PC A04/MF A01.

This report presents the status of the Nuclear Safeguards Research and Development program pursued by the Los Alamos Scientific Laboratory Safeguards Groups Q-1, Q-2, Q-3, Q-4, Q-5, and CMB-1. Topics covered include nondestructive assay technology development and applications, international safeguards, perimeter safeguards and surveillance, concepts and subsystems development (e.g., DYMAC program), integrated safeguards systems, training courses, technology transfer, and analytical chemistry methods for fissionable materials safeguards.

25439 (LA—8319-MS) **Shift-register coincidence electronics system for thermal neutron counters.** Swansen, J.E.; Collinsworth, P.R.; Krick, M.S. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 26p. NTIS, PC A03/MF A01.

An improved shift-register, coincidence-counting logic circuit, developed for use with thermal neutron well counters, is described in detail. A distinguishing feature of the circuit is its ability to operate usefully at neutron counting rates of several hundred kHz. A portable electronics package incorporating the new coincidence logic and support circuits is also described.

25440 (NBL—293) **Progress report, October 1978-September 1979.** (Department of Energy, Argonne, IL (USA). New Brunswick Lab.). Mar 1980. 73p. NTIS, PC A04/MF A01.

The New Brunswick Laboratory is charged with the responsibility for monitoring and evaluating the measurement aspects of the materials accountability subsystem of the US Department of Energy (DOE) nuclear safeguards system. Specific missions are to: (1) develop and disseminate the application of new or improved methods of chemical and/or instrumental analysis, (2) develop, characterize, and distribute certified reference and calibration materials, (3) evaluate and assess the continuing level of chemical and instrumental measurement performance of government and industrial laboratories involved in the handling of nuclear materials, and (4) provide a variety of specialized measurement services in support of the government's nuclear materials programs. Technical efforts this period covered uranium, plutonium, NBL and NBS reference materials, evaluation, and quality assurance. (DLC)

25441 (ORNL/TM—7299) **Calculation of neutron die-away times in a large-vehicle portal monitor.** Lillie, R.A.; Santoro, R.T.; Alsmiller, R.G. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 23p. NTIS, PC A02/MF A01.

Monte Carlo methods have been used to calculate neutron die-away times in a large-vehicle portal monitor. These calculations were performed to investigate the adequacy of using neutron die-away time measurements to detect the clandestine movement of shielded nuclear materials. The geometry consisted of a large tunnel lined with He^3 proportional counters. The time behavior of the (n,p) capture reaction in these counters was calculated when the tunnel contained a number of different tractor-trailer load configurations. Neutron die-away times obtained from weighted least squares fits to these data were compared. The change in neutron die-away time due to the replacement of cargo in a fully loaded truck with a spherical shell containing 240 kg of borated polyethylene was calculated to be less than 3%. This result together with the overall behavior of neutron die-away time versus mass inside the tunnel strongly suggested that measurements of this type will not provide a reliable means of detecting shielded nuclear materials in a large vehicle. 5 figures, 4 tables.

25442 (UCRL—52879) **Determination of plutonium isotopic abundances by gamma-ray spectrometry. Interim report on the status of methods and techniques developed by the Lawrence Livermore Laboratory.** Gunnink, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-48. 50p. NTIS, PC A03/MF A01.

This report presents an overview of methods and techniques developed by the Lawrence Livermore Laboratory for determining plutonium isotopic abundances from gamma-ray spectra that have been measured with germanium detectors. The methodology of fitting the spectral features includes discussions of algorithms for gamma-ray and x-ray peak shape fitting and generation of response spectra profiles characteristic of specific isotopes. Applications of the techniques developed at government, commercial, and Japanese reprocessing plants are described. Current development of the methodology for the nondestructive analysis of samples containing nondescript solid materials is also presented.

25443 (LA-tr—80-14) **Development of a monitoring concept for separation nozzle installations. Final report of Project Definition Phase, 1976.** Bahm, W.; Didier, H.J.; Gupta, D.; Schwegmann, P. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). May 1980. Translation of KFK—2894, 1979. 49p. NTIS, PC A03/MF A01.

This work presents an initial concept for monitoring the flow of fissionable material and the stock of nuclear material in a uranium enrichment plant running under the separation nozzle process. The present initial concept forms the conclusion to a project definition phase in which the specific requirements, formulations, and problems, which have arisen from the necessities of nuclear material monitoring by the authorities, have been developed. Initial calculations have shown that under simplifying assumptions the range of deviation for detecting the inventory of nuclear material is too high, measured by the limiting values currently given by the monitoring authorities. This control of nuclear material is however made subject to greater precision via a series of measures: checking the accuracy of information which is attainable by the instrumentation assumed for operation; development of alternative concepts for the assimilation of the actual stock in all parts of the plant where the concept breaks down with respect to verifiability of the nuclear material content; additional safeguard-specific instrumentation of parts of the plant in which the measurement methods do not lead to a result; evaluation of the gas inventory, the deposition of nuclear material, and the leakage of the entire installation; R & D for determining the correlations between the measured primary data and the quantitative information deducible therefrom, and of checking the relevant assumptions; and representing the quality of the record and report systems with the help of a reference campaign.

ADMINISTRATIVE AND REGULATORY

25444 (LA-UR—80-1115) **Proposed policy for decontamination and decommissioning.** Healy, J.W. (Los Alamos Scientific Lab., NM (USA)). 10 Apr 1980. Contract W-7405-ENG-36. 10p. (CONF-800470—1). NTIS, PC A02/MF A01.

From DOE decommissioning criteria workshop; Kansas City, MO, USA (15 Apr 1980).

Guidelines for decontamination and decommissioning were presented and discussed at this workshop. Statements considered were: (1) the dose limits will be those currently available as federal guidance from the President or as regulation; (2) the actual cleanup will be conducted to provide final levels as low as can be reasonably achieved; (3) DOE will retain effective direction of the work during its progress; (4) a precleanup survey, including both radiological measurements and thorough documentation of the previous use or uses of the property will be made to assist in planning; (5) the use of single radionuclide to serve as an indicator for a group of radionuclides shall be proven to be valid for each area; (6) all operations during the initial survey, cleanup, and final certification of the area will be thoroughly documented; (7) the final judgment on the suitability of the area for its final use will be made from a final certification survey along with consideration of the information collected during the cleanup; and (8) instrumentation, sampling methods and analytical methods shall be properly calibrated, shall have appropriate sensitivity and shall be capable of giving results in a time meaningful to the cleanup operations or certification survey. (DC)

25445 (SAND—78-1332) **State policies and requirements for management of uranium mining and milling in New Mexico. Volume III. Adverse effects of uranium mining and milling on the physical environment.** Tierney, M.S.; Vandevender, S.G. (Sandia National Labs., Albuquerque, NM (USA)). Aug 1979. Contract AC04-76DP00789. 173p. NTIS, PC A08/MF A01.

This volume contains two parts. The first part is a summary of issues. It complements the second part which is a program plan proposed by the New Mexico Environmental Improvement Division (NMEID) for the study and mitigation of environmental effects of uranium mining and milling. The NMEID program plan was begun when the lack of an adequate data base upon which the NMEID could base recommendations for new environmental laws and regulations applying to the uranium mining and milling industry was perceived. The NMEID planning document notes that, in the absence of adequate scientific data, State decisions regarding the regulation of the uranium industry may prove to be overly restrictive or not as restrictive as is necessary to assure protection of the public and the environment. To counter these tendencies, certain plans for cooperative studies involving Federal and State agencies are proposed. In particular, there is the need to improve the data base for determining population radiation exposure in affected areas and to evaluate the data needs for developing an ambient radon standard. It is concluded that the DOE's mission of energy development would be advanced by the provision of technical assistance and, in some cases, funds for certain State programs that demonstrably contribute to the State's ability to deal with Federal regulatory agencies as an informed, independent agent in regard to problems of uranium development.

25446 **Waste isolation pilot plant.** Washington, DC; US Government Printing Office (1979). 42p.

Testimony from DOE witnesses relating to the Waste Isolation Pilot Plant near Carlsbad, NM, is recorded. Topics covered

include: the power of the State of New Mexico to stop construction or operation of the project at any stage; the DOE authorization bill, and licensing of the project by the DOE and the NRC. (DC)

FUSION FUELS

SOURCES

25447 Hydrogen isotope separation. Bartlit, J.R.; Denton, W.H.; Sherman, R.H. US Patent Application 037,603. [nd]. 8p.

Disclosed is a system of four cryogenic fractional distillation columns interlinked with two equilibrators for separating a DT and hydrogen feed stream into four product streams, consisting of a stream of high purity D_2, DT, T_2, and a tritium-free stream of HD for waste disposal.

HYDROGEN

REFER ALSO TO CITATION(S) 25145

PRODUCTION

ELECTROLYSIS

REFER ALSO TO CITATION(S) 25452, 25456

25448 (COO—5060-4) Hydrogen production by photoelectrolytic decomposition of H_2O using solar energy. Final report, July 22, 1977-July 21, 1978. Rauh, R.D.; Alkaitis, S.A.; Buzby, J.M.; Reise, T.F. (EIC Corp., Newton, MA (USA)). Feb 1979. Contract EC-77-C-01-5060. 76p. NTIS, PC A05/MF A01.

The purpose of this program is to develop new semiconducting electrodes for the economical efficient photoelectrochemical decomposition of H_2O using solar energy. Due to the intimacy of the liquid-solid rectifying junction, this technique is particularly well-suited to inexpensive polycrystalline electrode fabrications. During the past year, work has concentrated on photoanode development, specifically anodically robust semiconducting oxides. It was found that some thin film oxides formed by a simple chemical vapor deposition (CVD) procedure perform quite well, with maximum solar power conversion efficiencies of 0.5 to 1.0% for CVD TiO_2 despite a band gap of 3.1 eV, which is a poor match for the solar spectrum. CuO, Fe_2O_3, WO_3 and some mixed oxide thin film electrodes were also prepared pyrolytically and showed good photoresponse. The argument is put forth, however, that no stable oxide photoanodes yet discovered have the combined properties of low electron affinity (EA) and optimal band gap required for the efficient photoelectrolysis of H_2O. Compounds like TiO_2 and $SrTiO_3$ have satisfactory EA's, but their valence bands lie too deep, rendering their band gaps impractically large. It is probable that only d-band oxides would have valence bands high enough in energy to give rise to this combination of properties. In order to produce such materials, over 60 new perovskites and rutiles containing d/sup n/ transition metals have been synthesized and evaluated as sintered disc photoelectrodes. Mostly 3d metal oxides were investigated. Sensitization of photocurrents to the visible portion of the spectrum was noted in several cases confirming this materials design philosophy. As a rule, photocurrent quantum yields were lower for the d/sup n/-substituted oxides than for the wide band gap, d°-oxides like $SrTiO_3$ and TiO_2. This is ascribed partially to poor mobility of the d electrons.

THERMOCHEMICAL PROCESSES

25449 (CONF-800544—1) Acid-base model for thy—mochemical water splitting. Results of experimental tests on manganese-based thermochemical cycles. Robinson, P.R.; Kilyk, J. Jr. (Oak Ridge National Lab., TN (USA); Kenyon Coll., Gambier, OH (USA)). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From Electrochemical Society meeting; St Louis, MO, USA (11 May 1980).

An acid-base model for thermochemical water splitting cycles is described, together with the results of its application to cycles based upon reactions of manganese oxides. Experiments confirmed that at least 12 acids-HCl, H_2SO_4, H_3PO_4, MoO_3, $NaPO_3$, $Na_4P_2O_7$, SiO_2, Cr_2O_3, TiO_2, Al_2O_3, SnO_2, and Fe_2O#-drive the thermal decomposition of $NaMnO_2$ at temperatures below 1400°K. Only rather strong bases-NaOH, LiOH, BaO, Li_2CO_3, Na_2CO_3-can drive the steam oxidation of Mn(II) below 1300°K. In accord with the model, the acids HCl, H_2SO_4, H_3PO_4, and MoO_3 are too strong to be used in Mn(III)/(II) cycles, because their Na, Li, and Ba salts are too stable. Cycles were demonstrated with the other 8 acids and either NaOH or Na_2CO_3. Because such cycles evolve O/sub 2(g)/ in the presence of air, solar furnaces are appropriate sources of thermal energy for them.

25450 (GA-A—15777) Hydrogen production by the GA sulfur-iodine process: a progress report. Besenbruch, G.E.; McCorkle, K.H.; Norman, J.H.; O'Keefe, D.R.; Schuster, J.R.; Yoshimoto, M. (General Atomic Co., San Diego, CA (USA)). Mar 1980. Contract AC02-80ET26225. 16p. (CONF-800616—6). NTIS, PC A02/MF A01.

From 3. world hydrogen energy conference; Tokyo, Japan (23 Jun 1980).

A summary of the progress of the overall total development effort of the General Atomic (GA) sulfur-iodine thermochemical water-splitting cycle over the last two years is reported. The major accomplishments have been the following: (1) Significant improvements in the chemistry of the process. (2) Development, review, and revision of an engineering flowsheet, resulting in a thermal process efficiency of 47%. (3) Screening, identification, and testing of potential materials-of-construction for the corrosive process fluids. (4) Small-scale demonstration of the cycle in a closed loop under recycle conditions. (5) Installation of bench-scale equipment and demonstration of parts of the process in this system. (6) Development of a conceptual, preliminary flowsheet for the GA sulfur-iodine cycle driven by solar energy. The results of the work carried out during the last two years have demonstrated that thermochemical water splitting by the sulfur-iodine cycle is a feasible process and have provided confidence that thermal efficiencies in the range of 50% are achievable.

25451 (LA-UR—80-1400) Hydrogen production from the solar based LASL cadmium cycle. Mason, C.F.V.; Bowman, M.G.; Behrens, R.G. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800806—2). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A thermochemical H_2 cycle is presented where the high temperature step can be powered by a solar heat source. The cycle consists of three reactions: the thermal decompositions of CdO and $CdCO_3$ and the oxidation of Cd using water and CO_2 to form $CdCO_3$ and H_2. Experimental data is presented which indicates that CdO(g) is less stable than previously thought. Kinetic studies of the H_2 producing reaction show both Pd and NH_4Cl to be good catalysts. NH_4Cl, although introducing more possibilities for side reactions, appears to be the better catalyst. Drying studies on $CdCO_3$ show that water retention problems are minimal.

25452 Heat penalty and economic analysis of the hybrid sulfuric acid process. Carty, R.H. (Kentucky Center for Energy Research Lab., Lexington); Conger, W.L. *Int. J. Hydrogen Energy;* **5**: No. 1, 7-20(1980).

A heat penalty and economic analysis of the Westinghouse hydrogen process is made showing that the process efficiency is about 50.9% and the production cost of hydrogen based on 1976 cost figures is $8.20/GJ. A breakdown of the equipment in the process with the enthalpy change, entropy change, heat and work requirements, and heat penalty for each piece is given.

25453 Basic chemistry of a new cycle, based on reactions of Ce(III) titanate, for splitting water. Bamberger, C.E.; Nichols, D.H. (Oak Ridge National Lab., TN). *Int. J. Hydrogen Energy;* **4**: No. 6, 513-516(1979).

The chemistry of a new thermochemical cycle for splitting water is described. It consists essentially of three reactions: (a) Ce(IV), as CeO_2, is reduced to Ce(III) by reaction with TiO_2, evolving oxygen and forming one or more Ce(III) titanates; (b) the Ce(III) titanates react with molten NaOH to evolve hydrogen, and form CeO_2 and Na-titanate; and (c) the sodium titanate is hydrolyzed by boiling water into a hydrous titanium dioxide and a sodium hydroxide solution. The cycle has been demonstrated with regenerated materials.

WATER GAS PROCESSES

25454 Homogeneous catalysis of the water gas shift reaction using iron pentacarbonyl. King, A.D. Jr.; King, R.B.; Yang, D.B. (Univ. of Georgia, Athens). *J. Am. Chem. Soc.;* **102**: No. 3, 1028-1032(30 Jan 1980).

Measurements have been carried out to determine the rate of hydrogen production by the water gas shift reaction ($CO + H_2O \rightarrow CO_2 + H_2$) operating at temperatures less than 200°C with iron pentacarbonyl serving as a catalyst precursor in a basic methanol-water solution. Turnover numbers of 2000 mol H_2/mol $Fe(CO)_5$ per day are achieved at 180°C with this system. The reaction is shown to be zero order with respect to carbon monoxide. The temperature dependence of this reaction corresponds to an activation energy of 22 kcal/mol. It is shown that a threshold pressure of carbon monoxide exists above which the catalytic reduction of water can be

sustained. Below this pressure, the $Fe(CO)_5$ is destroyed in a stoichiometric reduction of water. The overall kinetics of this reaction as well as this threshold phenomenon can be explained according to previously published mechanisms.

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

25455 (SAN—0034/239-1-T2) **Solar energy conversion through biophotolysis. Third annual report, 1 April 1978-31 March 1979.** Benemann, J.R.; Murry, M.A.; Hallenbeck, P.C.; Miyamoto, K.; Olafsen, A.G.; Esteva, D.J.; Kochian, L.V. (California Univ., Berkeley (USA). Sanitary Engineering Research Lab.). 1 May 1979. Contract EY-76-S-03-0034-239. 236p. NTIS, PC A11/MF A01.

This report covers the progress during the third year of this project. The state-of-the-art of biophotolysis was reviewed and a bioengineering analysis carried out. The conclusions were that practical biophotolysis systems are feasible; however, they will require, in most cases, relatively long-term R and D. The biophotolysis system developed under this project, utilizing heterocystous blue-green algae, was demonstrated both indoors and outdoors with a model converter system using the heterocystous blue-grees alga Anabaena cylindrica. Maximal light energy conversion efficiencies were 2.5% indoors and about 0.2% outdoors, averaged for periods of about two weeks. Achievement of such rates required optimization of N_2 supply and culture density. A small amount of N_2 in the argon gas phase used to sparge the cultures was beneficial to the stability of a long-term hydrogen-production activity. A relatively small amount of the hydrogen produced by these cultures can be ascribed to the activity of the reversible hydrogenase which was studied by nitrogenase inactivation through poisoning with tungstate. The regulation of nitrogenase activity in these algae was studied through physiological and immunochemical methods. In particular, the oxygen protection mechanism was examined. Thermophilic blue-green algae have potential for biophotolysis; hydrogen production was studied in the laboratory. Preliminary experiments on the photofermentation of organic substrates to hydrogen was studied with photosynthetic bacteria.

STORAGE

CHEMISORPTION

REFER ALSO TO CITATION(S) 25940

25456 (BNL—26923) **Electrolysis-based hydrogen storage technology.** Strickland, G. (Brookhaven National Lab., Upton, NY (USA)). Nov 1979. Contract AC02-76CH00016. 5p. (CONF-791103—112). NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

Production and storage technology pertinent to the Hydrogen Program at Brookhaven National Laboratory is briefly described. The major development areas deal with advanced water-electrolysis systems, hydrogen storage materials and systems, and end-use applications. Related work by organizations having contracts managed by BNL is included. Work on hydrogen production deals with improving the system for KOH electrolysis, and on developing the acidic solid-polymer-electrolyte system for the electrolysis of water. The advantages of the techniques for storing hydrogen via metal hydrides and hollow glass microspheres are described. TiFe-based hydride has been tested as an energy storage medium for electric energy storage, for automotive fuel, and for bulk hydrogen storage. Pairs of selected hydrides have been used in tests simulating a solar-driven heat pump. The pressure-temperature characteristics of hydrides are being utilized in development of a hydrogen chemical compressor. Glass microspheres are being studied for the automotive fuel application.

25457 (DOE/CS/0016—T2) **Metallurgical studies of hydrogen storage alloys. Final report.** (International Nickel Co., Inc., Suffern, NY (USA). INCO Research and Development Center). Apr 1980. Contract AC02-76CH00016. 218p. NTIS, PC A10/MF A01.

The results of an extensive experimental program designed to understand the surface poisoning of metal hydrides by impurities in the hydrogen used are reported. Alloys investigated were $LaNi_5$, FeTi, and $Fe_{0.85}Mn_{0.15}Ti$. Gaseous impurities studied were O_2, H_2O, and CO. The nature of the surface structures formed, and consequently the degree of poisoning varies markedly from alloy to alloy and from impurity to impurity. A number of rate limiting reaction steps are apparent and examples of complex compound film formation, chemisorption, and possibly physisorption can be seen. Results show the hope of developing surface structures with significant resistance to impurity gases and especially the possibility of designing practical regeneration cycles.

PROPERTIES

REFER ALSO TO CITATION(S) 26222

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 26084

PROPERTIES

REFER ALSO TO CITATION(S) 26222

25458 (LBL—10655) **Interpretation of Rayleigh scattering in a flame.** Namer, I.; Schefer, R.W.; Chan, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 26p. (CONF-800408—3). NTIS, PC A03/MF A01.

From Conference of the western states section of the Combustion Institute; Irvine, CA, USA (21 Apr 1980).

Rayleigh scattering has become an accepted technique for the determination of total number density during the combustion process. The interpretation of the ratio of total Rayleigh scattering signal as a ratio of densities or temperatures is hampered by the changing composition and mean molecular weight through a flame. Typical values of correction factors as a function of degree of reaction, fuel, and equivalence ratio are calculated for an idealized one-dimensional flame front. The fuels considered are H_2, CH_4, C_2H_4, C_2H_6, and C_3H_8. Errors of up to 30% can occur in the interpretation of the Rayleigh scattering as gas density for the heavier hydrocarbon fuels due, primarily, to the presence of CO as an intermediate combustion product. Conversely, using H_2 as a fuel will result in a maximum error of 3%, which is within the expected experimental accuracy of a typical Rayleigh scattering system. The interpretation of Rayleigh scattering as temperature was found to have larger errors than the interpretation as density. Nevertheless, when corrections are applied for changes in gas composition, Rayleigh scattering provides an excellent measure of total gas density and temperature in flames. 7 figures, 2 tables.

PREPARATION

CHEMICAL SYNTHESIS

25459 (DOE/ER/04222—3) **Mechanistic studies related to the metal catalyzed reduction of carbon monoxide to hydrocarbons. Progress report, April 1, 1979-March 31, 1980.** Casey, C.P. (Wisconsin Univ., Madison (USA)). Apr 1980. Contract AC02-77ER04222. 11p. NTIS, PC A02/MF A01.

The stoichiometric reactions of metal complexes which parallel probable steps in the metal catalyzed reduction of CO are being investigated. It is hoped that the study of these model reactions will lead to an understanding of the structural factors influencing these individual reaction steps. The information obtained should be useful in the design and discovery of homogeneous catalysts for the reduction of CO to hydrocarbons. We have studied metal formyl complexes which may be involved in the initiation step in CO reduction and have compared metal formyl compounds with metal acetyl compounds. We have found that the structure and kinetic stability of metal formyl compounds are very similar to metal acetyl compounds. However, metal formyl compounds are thermodynamically much less stable than metal acetyl compounds towards decarbonylation. Hydride donation reactions of metal formyl compounds have been discovered. A neutral metal formyl compound has been discovered and its reactions have been investigated. Preparation of $(C_5H_5)Re(CO)(NO)(CH_2OH)$, the first authentic example of a hydroxymethyl metal compound, was accomplished and studies of its reactions with acid, with base, with CO, and with H_2 were begun.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 25586, 25587, 25590, 25592, 25595, 25597

25460 (COO—2983-12) **Energy and protein production from pulp mill wastes. Final report, 15 Jun 1976-14 Jun 1979.** Jurgensen, M.F.; Patton, J.T. (Michigan Technological Univ., Houghton (USA)). 14 Jun 1979. Contract AS02-76CS40216. 60p. NTIS, PC A04/MF A01.

The goal of this research was to convert the organics and sulfur in sulfite spent liquor (SSL) now classified as pollutants from sulfite pulp mills, into synthetic methane and protein by means of a combination chemical-biological process. Ozonization was used to break the high molecular weight lignosulfonate molecules present in SSL into lower weight fractions which could be metabolized by methane-producing bacteria and protein-producing yeast. Ozonization experiments showed that this treatment is effective in partially oxidizing and fragmenting lignosulfonates into fermentable substrates. This process is initiated at low ozone concentrations and proceeds rapidly until nearly 30% of the Chemical Oxygen Demand (COD) has been consumed. The conditions under which ozonization is conducted greatly affect the degree of oxidation and the molecular weight of the cleaved fragments. In spite of the appreciable oxidative cleavage of the lignosulfonate molecules, continuous-flow fermentation studies showed rather low yields of methane and yeast from ozonated SSL. Under optimum conditions, methane production averaged only 1.7 1/1 of SSL or approximately 3% of the total organics present. Protein production was somewhat more favorable with 6% of the organics being converted to yeast biomass. (6g/1). Neither fermentation fully used all of the oxygenated fragments produced by ozonization, and thus, a two-stage process might yield better results. Although it appears that ozonization is not a viable treatment of SSL under present economic conditions, with increased demand for energy and protein, it could become more competitive in the future. However, of possibly greater importance is the potential use of partial oxidation treatments to improve the biodegradability of organic wastes.

25461 (DOE/CS/40177—T1) **Interim technical status report for the COthane contract.** (Union Carbide Corp., Tarrytown, NY (USA). Tarrytown Technical Center). Dec 1979. Contract AC03-78CS40177. 29p. NTIS, PC A02/MF A01.

Each year millions of tons of dilute carbon monoxide in industrial waste streams are flared or vented to the atmosphere. In order to recover this wasted source of energy, Union Carbide has developed the COthane process for the direct conversion of the dilute carbon monoxide in such streams to pipeline quality natural gas (SNG). A three phase program has been planned for the commercialization of the COthane process. Phase I will define the process details. Phase II will further test the process with an integrated pilot unit operating on industrial waste streams. Phase III will monitor the operation of the first commercial unit. The purpose of this interim report is to describe the preliminary work done under these five tasks during the first fourteen months of the contract. The bench scale pilot unit has been built and initial test runs started. New catalysts have been developed and tested which incorporate different matrixing agents, metal components, stabilizing agents, and synthesis techniques. Finally, the technical and economic studies have shown that, under certain optimistic conditions, a COthane unit handling blast furnace off-gas will produce SNG at $3.17/MM Btu. This cost is probably competitive with currently priced natural gas, and is certainly competitive with SNG produced by the Lurgi process.

25462 **Biothermal gasification of biomass.** Chynoweth, D.P.; Srivastava, V.J.; Henry, M.P.; Tarman, P.B. Chicago, IL; Institute of Gas Technology (1980). 29p. (CONF-800129—6).

From Energy from biomass and wastes 4 symposium; Lake Buena Vista, FL, USA (21 Jan 1980).

The BIOTHERMGAS Process is described for conversion of biomass, organic residues, and peat to substitute natural gas (SNG). This new process, under development at IGT, combines biological and thermal processes for total conversion of a broad variety of organic feeds (regardless of water or nutrient content). The process employs thermal gasification for conversion of refractory digester residues. Ammonia and other inorganic nutrients are recycled from the thermal process effluent to the bioconversion unit. Biomethanation and catalytic methanation are presented as alternative processes for methanation of thermal conversion product gases. Waste heat from the thermal component is used to supply the digester heat requirements of the bioconversion component. The results of a preliminary systems analysis of three possible applications of this process are presented: (1) 10,000 ton/day Bermuda grass plant with catalytic methanation; (2) 10,000 ton/day Bermuda grass plant with biomethanation; and (3) 1000 ton/day municipal solid waste (MSW) sewage sludge plant with biomethanation. The results indicate that for these examples, performance is superior to that expected for biological or thermal processes used separately. The results of laboratory studies presented suggest that effective conversion of thermal product gases can be accomplished by biomethanation.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 25998

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 25589, 25591, 25594

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 26220

HYDRO ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 25490

25463 (CONF-7905154—, pp 158-163) **Small-scale hydroelectric power resources study.** Sigleo, W.R. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The US Army Corps of Engineers is involved in assessing the nation's small-scale hydroelectric power resources. When completed in 1981 this study will provide much greater detail on resources at both existing and undeveloped sites. At the present level of analysis, the Corps has identified approximately 5800 existing small-scale dams which are either generating power, or have the potential for new or increased capacity. The total installed capacity at existing dams is estimated to be some 2300 MW with an average annual energy of about 12,000 GWH. New or additional capacity could be installed at nearly 90% of the existing dams for an estimated power production of 5700 MW and 17,000 GWH energy generation. It is important to note that these figures are preliminary, and that the totals do not include a number of sites which are still being analyzed. Refined estimates of the hydropower potential at small-scale dams will be issued as the data base becomes more complete. (LCL)

25464 (CONF-7905154—, pp 164-191) **Technical factors in small hydropower planning.** Davis, D.W. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The need for, development and status of a six-volume manual for determining the feasibility of adding small hydro-electric power to an existing facility are discussed. These volumes contain information on small hydro technology; economic and financial analysis; hydrologic studies; existing facility integrity; electromechanical equipment; and civil engineering features. Small hydropower projects are installations with 15 MW or less capacity. (LCL)

25465 (CONF-7905154—, pp 192-207) **Strategy for developing small hydropower opportunities in New York State.** Bishop, A.B. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Small hydropower represents an economically and environmentally acceptable method of supplementing and later replacing New York State's dependence on energy imports. Through its use, jobs will be expanded, industry will increase and municipal governments will be able to stabilize power costs. Towards this end, the State has undertaken a vigorous campaign to bring sites into operation at the earliest possible time. Specifically, it is being accomplished by maintaining an accurate inventory of potential sites, performing feasibility studies, redevelopment and demonstration projects. In addition, through technical and financial assistance, the State is encouraging the private and public sectors to develop small hydropower. If properly planned and implemented, the State's municipal governments, utilities, private industries and most importantly, its citizens will benefit. However, if it is to be successful, a coordinated cooperative effort must exist among these parties.

25466 (DOE/RA/03006—T1) **Goose River, Maine, demonstration project, January 1978-October 1978. Final report.** (Maine Hydro-Electric Development Corp., Belfast (USA)). 24 Nov 1978. Contract ET-78-G-01-3006. 147p. NTIS, PC A07/MF A01.

Portions of document are illegible.

The proposed Goose River Project is a commercial power development consisting of 4 power dams and one storage dam. All available energy is to be wholesaled to the Central Maine Power Company, the utility holding the franchise for the area. A description of the economic feasibility of the proposed project is presented.

25467 **Feasibility of five low-head hydro projects.** Williamson, J.V.; Pietz, A.W. (R.W. Beck and Assoc, Seattle, Wash). *J. Energy Div., ASCE;* **106**: No. 1, 57-68(Apr 1980).

Studies were performed under a Department of Energy (DOE) grant program to assess the feasibility of installing low-head

hydroelectric generating facilities at the following five existing dams in the United States: Tuttle Creek Dam, Kansas; Zumbro Dam, Minnesota; Piqua Dam, Ohio; Maxwell Dam, Pennsylvania; and Jackson Bluff Dam, Florida. To establish the economic feasibility of the projects if was necessary to compare the annual costs of the hydro project to the most economic alternative source of generation to meet the required load. Economic feasibility was determined utilizing both a first year benefit-cost analysis and a present-worth analysis for the first 10yr of project operation. Two of the projects indicate conclusive economic feasibility, two show marginal economic feasibility, and one is infeasible. In addition, based on the study results of the five projects, certain general conclusions are arrived at concerning installing generating facilities at existing low-head dams.

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 25494

25468 (CONF-7905154—, pp 255-296) **Available low head hydro technology.** Wayne, W.W. Jr. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The present status of equipment technology for low head hydroelectric developments is summarized. Included are descriptions and data on available types of turbogenerating equipment and information on small packaged units and standard designs. Approximate cost information suitable for guidance in making preliminary assessments of potential low head hydro sites is given.

25469 (DOE/ET/20518—1(Vol.1)) **Evaluation of hydroelastic and dynamic behavior of key components of the Ocean Turbine System. Final report, September 5, 1978-June 4, 1979. Volume I. Executive summary.** Lissaman, P.B.S.; Radkey, R.L.; Mouton, W.J.; Thompson, D.F. (AeroVironment, Inc., Pasadena, CA (USA)). May 1980. Contract AC03-78ET20518. 24p. NTIS, PC A02/MF A01.

This project consists of three interrelated tasks: (1) analysis of the hydroelastic performance of the rotor; (2) a water channel hydroelastic test of a 1 m diameter power-producing model rotor; and (3) an analysis of the anchor and mooring configuration and the dynamics of the moored Ocean Turbine units. Study results and conclusions and recommendations are summarized in this volume. (WHK)

25470 (DOE/ET/20518—1(Vol.2)) **Evaluation of hydroelastic and dynamic behavior of key components of the Ocean Turbine System. Final report, September 5, 1978-June 4, 1979. Volume II.** Lissaman, P.B.S.; Radkey, R.L.; Mouton, W.J.; Thompson, D.F. (AeroVironment, Inc., Pasadena, CA (USA)). May 1980. Contract AC03-78ET20518. 374p. NTIS, PC A16/MF A01.

An array of large Ocean Turbine units moored in the Gulf Stream about 30 km east of Miami could produce more than 10,000 MW with negligible environmental perturbations. Power from this array could be delivered onshore at an estimated plant cost, including transmission, of about $1200/kW. This report describes a project to analyze and test the dynamic and hydroelastic behavior of the units. The goal is to determine, at an early stage, configurations which will exhibit desirable dynamic behavior. The program consists of three tasks: (1) analysis of the hydroelastic performance of the rotor; (2) a water channel hydroelastic test of a 1 m dynamic power-producing model rotor; and (3) an analysis of the anchor and mooring configuration and the dynamics of the moored system. Ducted turbine performance has been calculated and the power extraction performance quoted has been found to be conservative in light of experimental results. A hydroelastic analysis has shown the catenary rotor to be free from adverse vibratory behavior. A water channel test of a representative 1 m rotor model confirmed this conclusion as no adverse vibrations were observed. A study of mooring configurations and the stability of the moored system has shown the unit to be stable in both power-on and power-off conditions. A preliminary cost estimate and cost/size trade study has shown that units with exit diameters of about 70 m (230 feet) have the lowest installed cost/kW.

REGULATIONS AND LICENSING

REFER ALSO TO CITATION(S) 25494

25471 (CONF-7905154—, pp 58-66) **Status of small scale hydropower and FERC licensing requirements.** Corso, R.A. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Licensing and permitting requirements of the Federal Energy Regulatory Commission as related to low-head hydro development are discussed. (LCL)

25472 (CONF-7905154—, pp 343-352) **Major legal problems in small scale hydroelectric development.** Brown, P.W. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Five areas in which legal systems impact significantly in Small Scale Hydroelectric Projects are discussed. These areas are the expanded FERC jurisdiction, overlapping federal regulatory requirements, duplicative state permit requirements, markets for hydropower and the new energy legislation and the variety of loan, tax and other subsidy programs for hydro projects.

25473 **Legal/institutional aspects of small scale hydro development.** Corso, R.A. *Energy Technol. (Wash., D.C.);* **6**: 950-960(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

Renewed interest in developing low-head hydro sites is evident in the growing number of applications received by the Federal Energy Regulatory Commission (FERC) and the number of preliminary permit applications pending. A potential developer, however faces institutional and legal problems which are both numerous and complex. The difficulties facing the potential developer are traced from the initial application for a permit or a license, through the hearing and processing steps, and after issuance of the license, citing problems at each step. Environmental statutes with overlapping authorities and overzealous implementation practices will require either legislative changes or agency cooperation. Other factors causing delays are proof of economic and financial viability, insurance requirements, and state and local taxes. The reforms initiated to offset these obstacles are aimed at shortening and simplifying the permit and licensing process. (DCK)

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 25465, 25468

25474 (CONF-7905154—) **Small/low-head hydropower PRDA-1706 contractor's symposium.** (EG and G Idaho, Inc., Idaho Falls (USA)). 8 May 1979. Contract AM07-76ID01570. 385p. NTIS, PC A17/MF A01.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Five executive summaries of low-head hydro power plant feasibility studies and 28 papers presented at the meeting are included. A separate abstract was prepared for each item. (LCL)

25475 (CONF-7905154—, pp 1-3) **Chubb River Sites, Village of Lake Placid, New York.** 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of rehabilitating 3 dam sites at Lake Placid, NY for low-head power generation was investigated. Only one site was found to be possibly economically feasible, and the stability of that dam is questionable. (LCL)

25476 (CONF-7905154—, pp 4-8) **Reactivation or expansion of Hotel Baker Hydroelectric Plant, St. Charles, Illinois.** 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of reactivating existing power generating equipment at the Baker Hotel in St. Charles, IL was studied. The project was found to be technically and environmentally feasible. Its economic feasibility depends upon whether financial assistance grants are available for the reconstruction. (LCL)

25477 (CONF-7905154—, pp 9-15) **Anderson-Cottonwood irrigation district, Diversion Dam on the Sacramento River.** 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing power generating facilities at the existing irrigation dam in Redding, CA was examined. The project was found to be technically and economically feasible, a capacity of 14.5 MW and annual output of 79,000 MWh is foreseen, and implementation of the project with a goal to have it operational by 1984 is recommended. (LCL)

25478 (CONF-7905154—, pp 16-18) **Greggs Falls hydroelectric facility, Goffstown, NH.** 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The technical, economic, environmental, and institutional factors associated with restoring and operating a low-head hydro plant at Gregg Falls in New Hampshire were assessed. It is recommended

that a run-of-river facility with a 7945 MWh annual output be installed and that the power produced be sold through the local utility. (LCL)

25479 (CONF-7905154—, pp 19-27) **Canton Hydroelectric Project, Collinsville, Connecticut.** 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of redeveloping power generation in combination with providing fishways for fish migration at the two existing dams in Connecticut was assessed and found to be technically, economically, and environmentally feasible. (LCL)

25480 (CONF-7905154—, pp 28-31) **Regional planning coordination to assist hydropower commercialization.** Pecoraro, J.M. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The development of a program for promoting and implementing low-head hydroelectric power generation in six New England states is described. (LCL)

25481 (CONF-7905154—, pp 40-47) **Potential hydroelectric power Dry Falls Dam, Coulee City, Washington Columbia Basin Project.** Hosey, H.P. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The steps followed in assessing the power potential of a dam in the Columbia Basin System are described. The feasibility of developing a low-head facility at Dry Falls Dam, an irrigation control dam in the Columbia Basin, was evaluated by considering hydraulic and economic conditions. It is concluded that development of the Columbia Basin irrigation district power plants represent a significant source of energy which is immediately available, and that development at some of the sites should commence in order to promote interest in low-head power plants. (LCL)

25482 (CONF-7905154—, pp 48-52) **Confederated tribes of Warm Springs, OR.** Edwards, J. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A proposed project for which the Confederated Tribes at the Warm Springs Indian Reservation in central Oregon plan to invest $10 million of tribal funds and which will install power generating and transmission equipment at an existing flow-regulating dam is discussed. The project is feasible from all points of view and represents the largest investment ever made by an Indian Tribe in its own future. (LCL)

25483 (CONF-7905154—, pp 53-57) **Joint Districts' Hydropower Assessment.** Hagiwara, A.K. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Results are presented of economic analyses of 10 dam sites in California which were studied for possible retrofitting from irrigation flow control only to flow control plus power generation. (LCL)

25484 (CONF-7905154—, pp 67-71) **Feasibility of Big Blue River Co-Dependent Hydroelectric Development-Feasibility report.** Feuerberg, S. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A series of seven existing dams along a 65-mile stretch of the Big Blue River in Southeast Nebraska was investigated. This 65-mile section of the watershed represents a total of 4444 of drainage area. The study investigated the feasibility of reconstruction and/or rehabilitation of the hydroelectric facilities; it was determined that if total redevelopment were undertaken, a total generating capacity of 3920 kW could be installed at a cost of $14.1 million, in 1979 dollars. This 3920 kW of capacity could generate an estimated 11.55 million kWh annually over an expected 30 y life of each of the generation units. If a mere rehabilitation of the original installations were undertaken,, a total capacity of 1415 kW could be installed at a cost of $3.4 million, again in 1979 dollars. This capacity could generate an estimated 6.7 million kWh annually. The results showed that only two of the seven sites, Barneston and Blue Springs, would be economically feasible for either rehabilitation or redevelopment. At some of the sites the installed generating capacity costs would be 3 to 4 times that of fossil-fueled units. (LCL)

25485 (CONF-7905154—, pp 72-74) **Tuttle Creek Project.** Mulholland, J.W.; Williamson, J.V. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economics of installing power generating equipment at the existing Tuttle Creek dam near Manhattan, Kansas was studied. The project was found to not be economically competitive with other sources of energy. (LCL)

25486 (CONF-7905154—, pp 75-104) **Feasibility assessment for renovating one or more of five existing dams on the Boardman River in Grand Traverse County, Mighigan and Traverse City, Michigan to provide additional hydroelectric generation capacity.** Emery, D.B. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economics aspects of rehabilitating or retrofitting 5 dams near Traverse City, MI for low-head hydro power generation were analyzed, and such rehabilitation was found to be feasible. A program to renovate all five dams over a 3 year period is recommended. (LCL)

25487 (CONF-7905154—, pp 105-138) **O'Shaughnessy and Griggs Dams on the Scioto River.** Linzell, L.; Pritchard, D. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing two hydroelectric power plants at two existing water supply dams on the Scioto River in Ohio was examined, and found to be financially feasible and without legal, technical, regulatory, social, or environmental deterrents. Development of the project is recommended. (LCL)

25488 (CONF-7905154—, pp 139-149) **Feasibility study for a low-head hydroelectric installation at Archusa Creek Dam.** Carlson, K.W.; Herring, J.W. Jr. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A feasibility study for the Archusa Creek dam near Quitman, Mississippi is presented. The study indicates that there are no apparent technical difficulties to prevent such a project and that a suitable turbine-generator could be obtained. The study further indicates that the project should be economically feasible for the Pat Harrison Waterway District (owners of the dam and lake) to construct if arrangements could be completed for interconnecting with the local utility and selling the energy to the utility. The utility (Mississippi Power Company) has expressed interest in such an arrangement.

25489 (CONF-7905154—, pp 150-157) **Low head hydroelectric development at High Falls State Park, Monroe County, Georgia.** Fletcher, G.R. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic, technical, environmental and social feasibility of installing hydro generating equipment at High Falls Dam in Georgia was studied. Although technically and economically feasible, such renovation might adversely affect state park functions and activities near the site. It is recommended that another site in the vicinity be examined. (LCL)

25490 (CONF-7905154—, pp 208-223) **Determination of feasibility of hydroelectric power generation at Patillas Reservoir, Puerto Rico.** Huetter, J. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the dam at the Patillas Reservoir in Puerto Rico for power generation was studied for technical and hydrologic aspects, for environmental, legal, and institutional considerations, and for economics. It was determined that 800 kW of peaking or 400 kW base load power would be available, the retrofit cost would be repaid in less than 6 y with a yield of more than 20% on the investment and the project would be environmentally desirable. Implementation of the retrofit plan is recommended. (LCL)

25491 (CONF-7905154—, pp 224-236) **Otter Creek hydroelectric feasibility report.** Vasilescu, M.S. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A study was performed to appraise existing hydro power facilities, to evaluate improvements to these facilities, and to recommend selected improvements to hydro plants along Otter Creek in Vermont. The installation of new generating units is recommended and would be financially desirable. (LCL)

25492 (CONF-7905154—, pp 237-241) **Bethlehem mink farm.** French, R. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Plans for reconditioning a run-of-the-river hydroelectric plant at the mink farm dam at Bethlehem, NH are described. A cross-flow turbine operating on a 62' head has been selected. Operation should begin in 1981. (LCL)

25493 (CONF-7905154—, pp 242-254) **Canton Hydroelectric Project, Canton, Connecticut.** Korhonen, C. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of redeveloping power generation in combination with providing fishways for fish migration at two existing dams

in Connecticut was assessed and found to be technically, economically, and environmentally feasible. (LCL)

25494 (CONF-7905154—, pp 297-314) **Shawmut Hydroelectric Project feasibility study presetation.** Poulin, G.C.; Adams, B.H. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

In order to make better use of the energy resources of central Maine, the feasibility of expanding the existing Shawmut Hydroelectric Plant was investigated. The physical characteristics of the existing project and the technical and economic aspects of the proposed expansion are described. The costs of alternative locations for the new units are compared, and the role of licensing time in the overall economics of the expansion program is discussed. (LCL)

25495 (CONF-7905154—, pp 315-326) **Normanskill hydroelectric facility.** Besha, J.A. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the more than 60 y-old Normanskill Hydroelectric facility near Guilderland, NY to achieve a modern low-head plant was studied. Retrofitting was recommended as technically feasible and economically beneficial. (LCL)

25496 (CONF-7905154—, pp 327-342) **Wareham, Massachusetts: marketing possibilities and feasibility results.** Wright, E.S.; Mankauskas, J.J. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing hydro power generating equipment at the Treemont Dam near Wareham, MA was studied. The results showed that there would be significant financial benefits to the town from a two-unit 250 kW capacity hydro plant and no enviromental or other barriers. It is recommended that the project move forward as quickly as possible. (LCL)

25497 (CONF-7905154—, pp 353-361) **Quality feasibility assessments at a minimum cost.** Willer, D.C. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Quality feasibility statements for hydroelectric power plants involve an accurate assessment of the power potential, proper sizing of the turbogenerator components and realistic evaluation of the overall project costs. The use of the Army Corps of Engineers manual in selecting equipment and estimating costs is shown. The importance of computerized simulation of site-specific operating conditions is stressed. (LCL)

25498 (CONF-7905154—, pp 362-369) **Quality feasibility assessment at minimum cost.** Lawrence, J.D. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Steps to be taken, the data required, and assumptions to be made in performing hydro power plant feasibility studies so as to minimize the cost and maximize the meaning of these feasibility studies are discussed. (LCL)

25499 (CONF-7905154—, pp 370-373) **Short-form feasibility studies.** O'Brien, E. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The need for minimizing the cost of feasibility studies for low-head hydro plants and logical simplified procedures for achieving this are discussed. (LCL)

25500 (CONF-7905154—, pp 374-376) **Quality feasibility study at minimum cost.** Wiedemann, P.F. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Methods and requirements for achieving quality feasibility studies for low-head hydro plants at the minimum cost are outlined. (LCL)

25501 (DOE/ID/01570—1) **Small/low-head hydropower PRDA-1706 feasibility assessments. Executive summaries.** (EG and G Idaho, Inc., Idaho Falls (USA)). May 1979. Contract AC07-76ID01570. 243p. (CONF-7905154—(Summ.)). NTIS, PC A11/MF A01.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Forty-nine papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

25502 (DOE/ID/01570—1, pp 1-3) **Bethlehem Dam hydroelectric project, Bethlehem, NH.** Polonsky, R. (Bethlehem Mink Farm, NH). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Plans for reconditioning a run-of-the-river hydroelectric plant at the mink farm dam at Bethlehem, NH are described. A cross-flow turbine operating on a 62' head has been selected. Operation should begin in 1981. (LCL)

25503 (DOE/ID/01570—1, pp 9-13) **Mora Canal Drop near Boise, Idaho.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The Boise Project Board of Control entered into a cooperative agreement with the US DOE to conduct a study to investigate the feasibility of developing hydroelectric power at an existing canal drop structure on the Boise Project in southwestern Idaho. The Board, in turn, issued a subcontract to Tudor Engineering Company to perform the study. The primary objective of the study was to develop information which would serve as basis for a decision whether or not to proceed with construction of the power facilities. The study concluded that the construction of the power facilities is feasible in all respects. The plant would have an installed capacity of 1900 kilowatts with an estimated annual energy output of 8,113,000 kilowatt-hours. The initial cost of the project would be approximately $1,800,000. The annual cost, including amortization, would range between $165,000 and $180,000, depending on the financing methods adopted. Energy production costs would range between $0.0203 to $0.022 per kilowatt-hour. The energy production curve closely matches the energy demand curve for the surrounding area. The Idaho Power Company has indicated a need for the energy and has offered to purchase all energy produced at the Mora Canal Drop for $0.026 per kilowatt-hour, thus making the project financially feasible under any of the current financing options. The study examined marketing potential, environmental impacts, social impacts and licensing requirements. A final step in the study was to develop a schedule for constructing the plant and putting power on line.

25504 (DOE/ID/01570—1, pp 14) **Archusa Creek Dam, Quitman, MS.** Carlson, K.W.; Herring, J. May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The technical and economic feasibility of installing hydroelectric generators at the Archusa Dam near Quitman, Mississippi was studied and the project was found to be feasible. (LCL)

25505 (DOE/ID/01570—1, pp 15-18) **High Falls Dam on Towaliga River, High Falls, Georgia.** Hilsen, N.B. (State of Georgia, Atlanta). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of constructing a low-head hydroelectric power plant at High Falls State Park in Georgia was evaluated. The study results are presented in terms of flow data, potential sites, components, environmental effects and cost. It was concluded that this project is technically, environmentally, and economically feasible, but there are conflicts in the recreational and fish management aspects of the Park and power generation aspects. (LCL)

25506 (DOE/ID/01570—1, pp 19-22) **Jackson Bluff Dam on the Ochlockonee River, Tallahassee, Florida.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic and technical feasibility of re-installing hydroelectric generating facilities at the existing Jackson Bluff Dam near Jacksonville, Florida was studied. No technical, environmental nor economic problems were found and further planning was recommended. (LCL)

25507 (DOE/ID/01570—1, pp 23-26) **Normanskill hydroelectric facility, Guilderland, NY.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the more than 60 y-old Normanskill hydroelectric facility near Guilderland, NY to achieve a modern low-head plant was studied. Retrofitting was recommended as technically feasible and economically beneficial. (LCL)

25508 (DOE/ID/01570—1, pp 27-30) **Peninsular Paper Company Dam on the Huron River, Ypsilanti, MI.** Lystra, D.W. (Ayres, Lewis, Norris and May, Inc., Ann Arbor, MI). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the Peninsular Paper Company Dam near Ypsilanti, MI to obtain a low-head power generating plant was studied. No adverse technical nor environmental aspects were found. It was not found to be cost-effective. With tax credits and low cost loans it could be financially feasible. (LCL)

25509 (DOE/ID/01570—1, pp 31-34) **Woodruff Narrows Dam on the Bear River, Uinta County, Wyoming.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of constructing a low-head hydroplant at the existing Woodruff Narrows Dam on the Bear River in Wyoming was studied. The site was deemed to be acceptable from a geotechni-

cal viewpoint, but hydro power development at the Dam is not economically feasible. (LCL)

25510 (DOE/ID/01570—1, pp 35-38) **Lowell Creek, Seward, AK.** Small, T.S. (CH2M Hill, Anchorage, AK). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing low-head hydro plants on Lowell Creek near Seward, Alaska was evaluated in terms of cost, environmental effects, and technical requirements. Due to the required shutdown for winter ice conditions, and the amount of rock carried in the creek which necessitates expensive intake structures, hydro development at this location is not feasible and is not recommended. (LCL)

25511 (DOE/ID/01570—1, pp 39-42) **Carlyle Reservoir on the Kaskaskia River, Carlyle, Illinois.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of a low-head hydro plant on the Carlyle Reservoir in Illinois was studied. Such a development is recommended. (LCL)

25512 (DOE/ID/01570—1, pp 43-45) **Restoration of Frog Hollow Mill hydroelectric plant, Middlebury, Vermont.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The technical, economical and environmental aspects of developing a low-head hydro plant on Otter Creek near Middlebury, VT were examined. It was concluded that the project would have a minimal environmental impact and is technically feasible, but would be marginally economical and requires more economic analysis. (LCL)

25513 (DOE/ID/01570—1, pp 46-49) **French Landing Dam on the Huron River, Van Buren Township, MI.** Lystra, D.W. (Ayres, Lewis, Norris and May, Inc., Ann Arbor, MI). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the French Landing Dam near Detroit, MI with turbogenerators for power production was evaluated as to technical, economic, and environmental aspects. It is recommended that 2 vertical turbines rated at 500 to 830 kW be installed at a cost of $1,242,000. (LCL)

25514 (DOE/ID/01570—1, pp 50-53) **Zumbro Dam on the South Fork Zumbro River, Rochester, Minnesota.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The results are presented of the feasibility assessment study under a DOE grant for the City of Rochester, Minnesota to determine if it is economical to add the third generating unit in the empty stall at the existing powerhouse at Zumbro Dam on the South Fork Zumbro River. The studies and investigations included site reconnaissance, system loads, growth rate, site hydrology, conceptual project arrangements and layouts, power output, estimates of construction costs and annual costs, economic analyses, development of a design and construction schedule and a preliminary environmental review of the proposed project alternatives. It was concluded that the proposed development poses no unusual technical problems and no significant adverse environmental effects are anticipated. It shows sufficient promise of technical, economic and financial feasibility, to justify the City entering into the next phase of work, the FERC License Application, as soon as possible so that the installation can be completed by October 1983. Concurrently with this, the City should make application to the DOE for a demonstration project grant under the second Project Opportunity Notice, responses to which will be solicited shortly. Installation of the new transformers as soon as possible will provide additional economic benefit to the City which could be realized in advance of the scheduled on-line date of October 1983.

25515 (DOE/ID/01570—1, pp 54-63) **Big Blue River hydroelectric development, Big Blue River, NE.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The technical and economic feasibility of developing the low-head hydroelectric power potential at seven dam sites on the Big Blue River in Nebraska was investigated. It was concluded that rehabilitation of the Barneston site for an installed capacity of 760 kW is feasible and should be studied further. (LCL)

25516 (DOE/ID/01570—1, pp 64-67) **Vulcan Power Facility on the Fox River, Appleton, Wisconsin.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of rehabilitating the Vulcan Hydroelectric power plant (near the world's first hydro plant which was installed in 1882) in Appleton, WI was studied. The installation of two adjustable blade turbines with a maximun capacity of 2200 kW is recommended. (LCL)

25517 (DOE/ID/01570—1, pp 68-73) **Max Starcke Park Dam, Seguin, Texas.** Koebig, A.H. (City of Seguin, TX). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of adding one or more hydro units to an existing low-head power plant at the Max Starcke Dam on the Guadalupe River in Seguin, TX was studied. The results show that an additional 500 kW of generating capacity at the Dam is economically justified, although costs would exceed annual benefits for the first 12 years. (LCL)

25518 (DOE/ID/01570—1, pp 74-77) **Four sites on the Mousam River, Kennebunk, ME.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility of redeveloping the hydro power potential of four low-head dams on the Mousam River near Kennebunk, ME was studied. Two dams sites are recommended for rehabilitation at this time. (LCL)

25519 (DOE/ID/01570—1, pp 78-80) **Tremont Dam on the Weweantic River, Wareham, Massachusetts.** Packard, R.F.; Wright, E.S. (United Technologies Research Center, East Hartford, CT). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing hydro power generating equipment at the Tremont Dam near Wareham, MA was studied. The results showed that there would be significant financial benefits to the town from a two-unit 250 kW capacity hydro plant with no environmental or other barriers. It is recommended that the project move forward as quickly as possible. (LCL)

25520 (DOE/ID/01570—1, pp 81-84) **Johnson Lake Inlet, Elwood, Nebraska.** Hamilton, E.L. May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing low-head hydro power plants at a dam site on the Central Nebraska canal system was examined. The proposal was found to be economically undesirable due to high construction costs, and further study ceased. (LCL)

25521 (DOE/ID/01570—1, pp 85-88) **Piqua Hydroelectric Project on the Great Miami River, Piqua, Ohio.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing hydro generating facilities at the existing Piqua Dam in Ohio was analyzed. Although technically and environmentally feasible, the cost of the project with a 400 kW capacity can not be justified, and cessation of these studies is recommended. (LCL)

25522 (DOE/ID/01570—1, pp 89-98) **Phillips Hydroelectric Project, Croton Falls, New York.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing hydro generating equipment near Croton Falls, NY was investigated and six potential redevelopment alternatives for the site were considered feasible and were evaluated. The comparative cost-benefit data for these alternatives are presented. (LCL)

25523 (DOE/ID/01570—1, pp 99) **Lower Main Canal hydro stations, Modesto, California.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility of developing low-head hydro power plants near Modesto, CA to produce power presently purchased from a neighboring power supplier was investigated and found to be marginal. (LCL)

25524 (DOE/ID/01570—1, pp 100-103) **Chicopee Falls Dam, Chicopee, MA.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility of installing a low-head hydro power unit at the Chicopee Falls Dam in Massachusetts was evaluated. The project was determined not to be feasible. (LCL)

25525 (DOE/ID/01570—1, pp 104-105) **Lewiston Canal development, Lewiston, Maine.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A feasibility assessment of the hydroelectric potential of sites on the Lewiston (Maine) Canal System showed that 3 low-head development alternatives compared favorably with fossil-fuel power

generation costs. It is concluded that the addition of generation to the Canal is justified and should proceed. (LCL)

25526 (DOE/ID/01570—1, pp 106-110) **High Falls Hydroelectric Plant, High Falls, NY.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of reactivating the High Falls (NY) Hydroelectric Plant by renovating or replacing existing equipment was evaluated by comparing the cost of power from the reactivated plant with power costs using oil-fired power plants. All alternatives indicate an operating cost deficit; that new equipment would be the most desirable; and that the relative amount of future operating deficit will depend on oil prices. (LCL)

25527 (DOE/ID/01570—1, pp 111-120) **Brighton Dam hydroelectric redevelopment, Brighton, Maryland.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The redevelopment of the Brighton Dam near Laurel, Maryland by the addition of a 500 kW generator in the existing power house was examined and found to be both technically and financially feasible with a benefit-cost ratio of 1.53:1 compared with an equivalent coal-based generation source. (LCL)

25528 (DOE/ID/01570—1, pp 121-124) **Hydroelectric power potential, Woonsocket Falls Dam, Rhode Island.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing low-head hydro generating units at one of three possible sites near Woonsocket Falls (Rhode Island) was examined. Two of the three sites were found to be financially feasible, and the development of one of these is recommended. (LCL)

25529 (DOE/ID/01570—1, pp 125-128) **Low-head hydropower on the Mill River, Northampton, Massachusetts.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing low-head generating facilities at 5 existing dams near Northampton, MA was studied. It was concluded that although such development presents no legal, technical, nor environmental problems, none of these projects would be financially feasible without substantial assistance in the form of financial grants. (LCL)

25530 (DOE/ID/01570—1, pp 129-136) **North Hartland Dam Project, North Hartland, VT.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing a generating unit at the existing North Hartland, VT Dam was investigated, and the proposed facilities were found to be technically, environmentally, and financially feasible. (LCL)

25531 (DOE/ID/01570—1, pp 137-139) **Enloe Dam on the Similkameen River, Oroville, Washington.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of rehabilitating the Enloe Dam and powerhouse in Washington for power generation was studied and found to be technically, environmentally, and financially feasible. Two units with a combined capacity of 3720 kW are recommended for installation. (LCL)

25532 (DOE/ID/01570—1, pp 140) **Brown Bridge, Keystone, Boardman, Sabin and Union Street Dams on Boardman River, Traverse City and Grand Traverse County, Michigan.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The results are presented of a study conducted in 1978 to determine the feasibility of rehabilitating one or more of the five existing dam sites located on the 19-mile portion of the Boardman River upstream from the mouth of the river in Traverse City, Michigan. Detailed data gathered during the study is presented and includes a description and evaluation of facilities at the sites, hydrologic analysis of the river basin, evaluation of the potential market for power which would be produced, and an appraisal of equipment that would be suitable for installation and economic and financial factors related to the potential development. Evaluation of economic and non-economic factors indicates that hydroelectric generation at four of the sites is economically beneficial and has no significant effect on the quality of life in the Boardman River area. Rehabilitation of Keystone Dam, the fifth site, is economically beneficial but since it involves re-establishing an impoundment, significant environmental changes will occur, some of which are detrimental.

25533 (DOE/ID/01570—1, pp 141-146) **Otter Creek hydroelectric feasibility report, Proctor, VT.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A study was performed to appraise existing hydro power facilities, to evaluate improvements to these facilities, and to recommend selected improvements to hydro plants along Otter Creek in Vermont. The installation of new generating units is recommended and would be financially desirable. (LCL)

25534 (DOE/ID/01570—1, pp 147-150) **Lake Frances power generating facilities, Siloam Springs, Arkansas.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The purpose of this study is to analyze the feasibility of developing the power potential of the Illinois River at the Lake Frances Dam. It was found that: the actual average power potential of the river is 1200 hp or 894 kW; the power can be easily utilized on the city of Siloam Springs' distribution system; the cost of an 850 kW hydro-generating facility is estimated to be $608,053; the annual total per kilowatt-hour cost to produce the power available at the dam varies from 17.1 mills per kilowatt-hour to 19.4 mills per kilowatt-hour; the installation would save nonrenewable types of energy, and, if the capital cost can be fixed at present day prices, the unit will become economically feasible as electric rates increase; and the hydro-power project will not support any remedial rehabilitation of the entire dam structure. It is concluded that: construction, operation, and maintenance of the Lake Frances hydro-power generating facility could be feasible if guidelines are published and the city is able to acquire the needed funds for the dam safety improvements, and if financing arrangements can be made using either subsidies, grants, bonds, or a combination of all three so that the capital costs can be fixed to assure an adequate future financial return. The hydropower facilities should be constructed, owned, and operated by the city of Siloam Springs, which has an immediate use for the power generated and means to finance at least a portion of the project. There will be no significant adverse environmental impact resulting from either the construction or operation of the hydro-power facilities.

25535 (DOE/ID/01570—1, pp 151-161) **St. Joseph River hydroelectric plants, five locations, Indiana and Michigan.** Stelle, W.W. (American Electric Power Service Corp., Canton, OH). May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of upgrading five existing hydro power plants on the St. Joseph River in Michigan and Indiana was studied and the installation of modern equipment was found to be technically and financially desirable with no adverse environmental impacts. (LCL)

25536 (DOE/ID/01570—1, pp 162-166) **Cataract Power Plant expansion on the Saco River, Saco, ME.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of producing more hydroelectric power at the dam site in Saco, ME by rehabilitating existing equipment or building a new power plant was examined and found to be of only marginal economic desirability. Further detailed studies are recommended. (LCL)

25537 (DOE/ID/01570—1, pp 167-170) **Turtle Creek Dam on the Big Blue River, Manhattan, Kansas.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing hydro generating facilities at the existing Turtle Creek Dam near Manhattan, Kansas was studied. Three 4750 kW units and one 500 kW unit would be installed. The project was considered to be technically feasible without adverse environmental effects. The economic feasibility depends on low-interest loans and satisfactory reservoir use changes. (LCL)

25538 (DOE/ID/01570—1, pp 171-173) **Joint irrigation districts hydropower assessment study, Turlock, CA.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility of low-head power generation at any of the 19 sites in California irrigation districts was evaluated. Twelve of the sites were found to be feasible and development of these sites is recommended. (LCL)

25539 (DOE/ID/01570—1, pp 174-187) **Dan River, Danville, Virginia.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of rehabilitating two dam sites in Danville, VA for hydro power generation was studied. Redevelopment of one was found to be too costly, and development at the second is considered marginal economically. (LCL)

25540 (DOE/ID/01570—1, pp 188-193) **Additional power generation at Upriver Dam on the Spokane River, Spokane, Washington.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of upgrading old equipment and of adding new generating capacity at Upriver Dam on the Spokane River was evaluated. Uprating the existing system was found to be the most economical proposition. (LCL)

25541 (DOE/ID/01570—1, pp 194-196) **Patillas Reservoir, Patillas, Puerto Rico.** Huetter, J.J. Jr. May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

A feasibility study of retrofitting the generating equipment at the Patillas Reservoir, PR identified an extremely favorable hydro development potential. A three phase implementation program is recommended. (LCL)

25542 (DOE/ID/01570—1, pp 197-200) **O'Shaughnessy and Griggs Dams on the Scioto River, Columbus, Ohio.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of developing hydro power plants at 2 existing water supply dams on the Scioto River in Ohio was examined and found to be economically desirable. (LCL)

25543 (DOE/ID/01570—1, pp 201-203) **Pawtucket Dam and Northern Canal, Lowell, MA.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility of installing generating equipment at the existing Pawtucket Dam near Lowell, MA was investigated and found to be feasible. Alternative development plans are recommended. (LCL)

25544 (DOE/ID/01570—1, pp 204-207) **Dam and power facilities on the Merrimack River, Sewall's Falls, Concord, NH.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The economic feasibility and cost of renovating a low-head power plant at Sewall's Falls in New Hampshire was investigated. A project cost of about $1760 per installed kW is forecast. A conceptual plan of the renovation is presented. (LCL)

25545 (DOE/ID/01570—1, pp 208-219) **Barge Canal on the Mohawk River, Little Falls, New York.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of rehabilitating or developing power generating facilities at three dam sites on the Mohawk River in NY was investigated. The Barge Canal site appears to be feasible and is recommended for development. Proposed site plans are presented. (LCL)

25546 (DOE/ID/01570—1, pp 220-223) **Dry Falls Dam potential hydroelectric power, Columbia Basin Project, Washington.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of retrofitting the irrigation dam at Dry Falls on the Columbia River in Washington for power generation was studied. An installed cost of $706/kW is forecast. Implementation of the renovation is recommended. (LCL)

25547 (DOE/ID/01570—1, pp 224-227) **Expansion of Shawmut Hydroelectric Project, Fairfield, Maine.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The technical, economic and environmental aspects of installing additional generating equipment at the Shawmut Hydro plant near Fairfield, ME were investigated. The addition of two 1700 kW tube turbines is recommended. (LCL)

25548 (DOE/ID/01570—1, pp 228-231) **Maxwell Locks and Dam, southwestern Pennsylvania.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing generating equipment at the Maxwell Locks and Dam on the Monongahela River was investigated. Installation of 4 standard tube units of 2000 kW capacity each is recommended providing satisfactory financing terms, e.g. 7% REA loan, are attainable. (LCL)

25549 (DOE/ID/01570—1, pp 232-238) **Broadwater Hydroelectric Project, Toston, MT.** May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The feasibility of installing generating units at the Toston irrigation dam in Montana was evaluated. An apron-mounted configuration was found to be economically feasible and is recommended. (LCL)

SOLAR ENERGY

25550 (SERI/SP—763-595) **Energy in Mexico: a profile of solar energy activity in its national context.** Hawkins, D. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 41p. NTIS, PC A03/MF A01.

The geopolitical, economic, and cultural aspects of the United States of Mexico are presented. Mexico's energy profile includes the following: energy policy objectives, government energy structure, organizations for implementation, indigeneous energy sources, imported energy sources, solar energy research and development, solar energy organizations and solar energy related legislation and administrative policies. International agreements, contacts, manufacturers, and projects are listed. (MRH)

25551 (SERI/TP—451-597) **SERI Information Data Bank Network.** Ubico, R.E. (Solar Energy Research Inst., Golden, CO (USA)). Feb 1980. Contract EG-77-C-01-4042. 6p. (CONF-800355—1). NTIS, PC A02/MF A01.

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The availability of accurate, timely information will be an important key in the continued spread of solar energy. The products and services available through the Solar Energy Information Data Bank, a national information network developed and operated by Solar Energy Research Institute with the participation of member organization, are described.

25552 (SERI/TR—351-358) **Basic research needs and priorities in solar energy. Volume II. Technology crosscuts for DOE.** Jayadev, J.S.; Roessner, D. (eds.). (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 93p. NTIS, PC A05/MF A01.

Priorities for basic research important to the future developments of solar energy are idenified, described, and recommended. SERI surveyed more than 120 leading scientists who were engaged in or knowledgeable of solar-related research. The result is an amalgam of national scientific opinion representing the views of key researchers in relevant disciplines and of SERI staff members. The scientific disciplines included in the report are: chemistry, biology, materials sciences, engineering and mathematics, and the social and behavioral sciences. Each discipline is subdivided into two to five topical areas-and, within each topical area, research needs are described and ranked according to the priorities suggested in the survey. Three categories of priority were established: crucial, important, and needed. A narrative accompanying the description of research needs in each topical area discusses the importance of research in the area for solar energy development and presents the bases for the priority rankings recommended.

25553 (SERI/TR—351-358) **Basic research needs and priorities in solar energy. Volume I. Executive summary. Technology crosscuts for DOE.** Jayadev, T.S.; Roessner, D. (eds.). (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 49p. NTIS, PC A03/MF A01.

This report identifies, describes, and recommends priorities for basic research important to the future development of solar energy. In response to a request from the US Department of Energy, SERI surveyed more than 120 leading scientists who were engaged in or knowledgeable of solar-related research. SERI scientists relied heavily on the opinions of scientists polled, but weighted their own recommendations and opinions equally. The result is an amalgam of national scientific opinion representing the views of key researchers in relevant disciplines and of SERI staff members. The Scientific disciplines included in the report are: chemistry, biology, materials sciences, engineering and mathematics, and the social and behavioral sciences. Each discipline is subdivided into two to five topical areas and, wintin each topical area, research needs are described and ranked according to the priorities suggested in the survey. Three categories of priority were established: Crucial, important, and needed. A narrative accompanying the descripton of research needs in each topical area discusses the importance of research in the area for solar energy development and presents the bases for the priority rankings recommended.

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 25738, 25784, 25799

25554 (SAND—80-7009) **Circumsolar radiation.** Watt, A.D. (Watt Engineering Ltd., Cedaredge, CO (USA)). Apr 1980. Contract AC04-76DP00789. 283p. NTIS, PC A13/MF A01.

A quantitative knowledge of circumsolar radiation is important in the design of focusing type solar collectors, and is also of interest to those calculating the performance of all types of collec-

tors. The primary objective of this study is the development of a model which will permit estimation of circumsolar radiation based on solar and meteorological input data. The results of observations are presented including radiance characteristics and time variations of the circumsolar component at a number of locations. The characteristics of the atmosphere are presented with primary emphasis on large particles. Physical models of circumsolar radiation are developed. The results of observed clear day only and all day average monthly values at Albuquerque, NM are shown. Also shown are calculated values for both clear and average days based on the physical model. The model results are based on: long term average turbidity values, derived average pollen loadings, and actual monthly average sky cover values for the years shown. Regression analysis is employed to determine the circumsolar values based on observed solar radiation and atmospheric parameters. The regression derived models show that fairly good agreement can be obtained between observed and calculated monthly average circumsolar ratios by simple expressions employing only the active cavity radiometer values. (WHK)

ECONOMICS

REFER ALSO TO CITATION(S) 25279, 25599

25555 (SERI/TP—245-430, pp 183-187) **Solar economics.** Hellenbrand, V.J. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

There is a great need to simplify the economics of solar systems for heating space and service hot water. Just using life cycle costing information is adding to the confusion. We feel that utilizing the economics from a life cycle costing standpoint and then arriving at a fixed cost for the energy would be a more meaningful method. The energy from an active solar system could then be compared to the cost of the fuels that would be displaced through the use of a solar system. The fixed cost of solar then can be compared to the fuels available in various parts of our country and at the prices applicable in that particular area. These current fuel costs for home heating range from less than $5.00 per million Btu's to over $20.00 per million Btu's.

25556 (SERI/TR—353-280) **Sensitivity analysis of SPURR.** Witholder, R.E. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 114p. NTIS, PC A06/MF A01.

The Solar Energy Research Institute has conducted a limited sensitivity analysis on a System for Projecting the Utilization of Renewable Resources (SPURR). The study utilized the Domestic Policy Review scenario for SPURR agricultural and industrial process heat and utility market sectors. This sensitivity analysis determines whether variations in solar system capital cost, operation and maintenance cost, and fuel cost (biomass only) correlate with intuitive expectations. The results of this effort contribute to a much larger issue: validation of SPURR. Such a study has practical applications for engineering improvements in solar technologies and is useful as a planning tool in the R and D allocation process.

25557 (SERI/TR—353-459) **Investigation of learning and experience curves.** Krawiec, F.; Thornton, J.; Edesess, M. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 193p. NTIS, PC A09/MF A01.

The applicability of learning and experience curves for predicting future costs of solar technologies is assessed, and the major test case is the production economics of heliostats. Alternative methods for estimating cost reductions in systems manufacture are discussed, and procedures for using learning and experience curves to predict costs are outlined. Because adequate production data often do not exist, production histories of analogous products/processes are analyzed and learning and aggregated cost curves for these surrogates estimated. If the surrogate learning curves apply, they can be used to estimate solar technology costs. The steps involved in generating these cost estimates are given. Second-generation glass-steel and inflated-bubble heliostat design concepts, developed by MDAC and GE, respectively, are described; a costing scenario for 25,000 units/yr is detailed; surrogates for cost analysis are chosen; learning and aggregate cost curves are estimated; and aggregate cost curves for the GE and MDAC designs are estimated. However, an approach that combines a neoclassical production function with a learning-by-doing hypothesis is needed to yield a cost relation compatible with the historical learning curve and the traditional cost function of economic theory.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 25568, 25599, 25600, 25992

25558 (ORNL/TM—7189) **Decentralized Solar Energy Technology Assessment Program: review of activities (April 1978-December 1979).** Bronfman, B.H.; Carnes, S.A.; Schweitzer, M.; Peelle, E.; Enk, G. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 102p. NTIS, PC A06/MF A01.

The Decentralized Solar Energy Technology Assessment Program (TAP), sponsored by the Office of Solar Energy, Department of Energy, is a technology assessment and planning activity directed at local communities. Specifically, the objectives of the TAP are: (1) to assess the socioeconomic and institutional impacts of the widespread use of renewable energy technologies; (2) to involve communities in planning for their energy futures; and (3) to plan for local energy development. This report discusses two major efforts of the TAP during the period April 1978 to December 1979: the community TA's and several support studies. Four communities have been contracted to undertake an assessment-planning exercise to examine the role of solar renewable energy technologies in their future. The communities selected are the Southern Tier Central Region of New York State, (STC); Richmond, Kentucky, Kent, Ohio; and Franklin County, Massachusetts. Descriptions and progress to date of the community TA's are presented in detail. Two major support study efforts are also presented. A review of existing literature on the legal and institutional issues relative to the adoption of decentralized solar technologies is summarized. A preliminary analysis of potential socioeconomic impacts and other social considerations relative to decentralized solar technologies is also described.

25559 (SERI/TP—245-430, pp 147-150) **Solar bank and other solar legislation in the 96th Congress.** Adlhock, T. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The introduction of the legislation for the Solar Energy Bank, its progress in the legislative process, its impact, existing incentives and programs, and other solar legislative issues are discussed. (MHR)

SOLAR ENERGY CONVERSION

25560 **Method of storing solar energy.** Candor, J.T. US Patent 4,174,979. 20 Nov 1979. Filed date 10 Apr 1978. 6p.

A method of storing solar energy in the immediate vicinity of available solar energy is described. The method comprises the generation of electrical current with the available solar energy and charging a strip of electret producing material directly with the electrical current so that the strip of material is changed into a strip of electret means that can be subsequently utilized to produce work, such as forming part of an electrostatic separator unit, whereby the available solar energy need not be transmitted in any form other than by the produced electret means. 10 claims.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 25767, 25795

25561 (AD-A—077684/9) **Low resistivity-high minority carrier lifetime single crystal silicon investigation. Interim technical report jul 77-sep 78.** Stella, P.M.; Opjorden, R.W. (Spectrolab, Inc., Sylmar, CA (USA)). Apr 1979. Contract F33615-77-C-2045. 50p. NTIS, PC A03/MF A01.

The objective of this program is to improve the performance of N+/P silicon solar cells by improving the minority carrier lifetime of moderate to low resistivity silicon material. The behavior of cells fabricated from improved material will be demonstrated by measuring electrical output without irradiation and after 1 MeV electrons and 10 MeV proton irradiation. This report discusses the first fifteen months' efforts toward developing and evaluating a new solar cell silicon material. During this time period, equipment and techniques for material growth have been developed along with analysis of methods for removing impurities from non-ultra pure silicon after wafer fabrication. Five preliminary ultra pure ingots have been grown using boron ion implantation and a single ingot using elemental gallium to provide the P dopant. Results are presented for solar cells made from the ingots.

25562 (BNL—51145) **Advanced amorphous materials for photovoltaic conversion. Annual report, October 1, 1978-September 30, 1979.** Griffith, R.W.; Kampas, F.J.; Vanier, P.E.; Hirsch, M.D. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 17p. NTIS, PC A02/MF A01.

The objectives of this project are twofold: (1) to investigate new amorphous semiconductor (a-SC) materials, in which recombination centers are passivated, using plasma deposition techniques; and (2) to characterize the optoelectronic properties pertaining to both majority-carrier and minority-carrier transport in as-deposited films and in devices. The electronic properties of plasma-deposited a-Si:H alloys were studied as functions of oxygen and nitrogen impurities. Over a wide range of processing conditions, features displayed by the data include: (1) anomalous behavior in photoconductivity versus temperature for films deficient in either, or both, impurities (peaks appear that are associated with thermal-quenching processes and supralinearity); and (2) modification to classic behavior in photoconductivity owing to synergistic effects of oxygen and nitrogen. Correlations with photoluminescence were observed. Within the context of an emerging spectroscopy, optical emission spectroscopy was found to be a useful technique for the detection of emitting reactive species in the plasma. The presence of impurities, such as N_2 and chlorosilanes, was diagnosed.

25563 (COO—4094-88) **Advanced combined photovoltaic/thermal collector: design and testing.** Hendrie, S.D.; Raghuraman, P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract AC02-76ET20279. 3p. (CONF-800604—27). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

An improved, flat-plate, combined photovoltaic/thermal (PV/T) air-type solar collector has been designed and built at MIT Lincoln Laboratory. The design results from experience gained through detailed analytical studies and performance testing of a first-generation prototype air PV/T collector. Analytical modeling of improved collector performance indicates a maximum total collector efficiency, thermal plus electrical operating at the maximum power point, of 51% when normalized to the overall collector area and a maximum efficiency of 63% when normalized to the thermal absorber area. A discussion of the improved collector design and results of analytical studies and first-generation collector test measurements is presented.

25564 (COO—5015-T1) **Preparation and characterization of amorphous silicon. Quarterly technical progress report No. 3, 1 December 1979-29 February 1980.** (Naval Weapons Center, China Lake, CA (USA)). 1980. Contract EY-77-X-02-5015. 5p. NTIS, PC A03/MF A01.

The progress made on the fabrication of photodiodes on dc magnetron sputtered a-Si:H films is described. Schottky barriers are being made to evaluate the suitability of this material for solar cell applications. Once consistency in the diode structure is demonstrated, pertinent material properties can be measured and optimized.

25565 (DOE/ET/20460—4) **Amorphous silicon thin film heterojunction solar cells.** Cretella, M.C.; Gregory, J.A.; Sandstrom, D.B.; Paul, W.P. (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). Mar 1980. Contract AC03-78ET20460. 71p. NTIS, PC A04/MF A01.

The initial task was to develop a flexible glow discharge apparatus capable of yielding reproducible uniform films of a-Si(H) to provide a reference material for comparison with subsequent alloyed materials. Following the completion of this task, C substituted and Ge substituted a-Si/sub x/M/sub 1-x/(H) alloys were prepared over a range of compositions and on a variety of substrate materials. Tin substitution was also attempted. As the next step, additional modification is to be attempted by replacing or substituting a part of the hydrogen with Li or the other alkali metals. The analogy in crystalline silicon is to use Li drifting to neutralize dangling bonds and other electrically active centers. Two types of measurements were made, (a) those to evaluate the material properties and (b) those to determine device characteristics. The techniques have included examining the features of the infrared vibrational spectra, the determination of the absorption edge and the optical energy gap, measurements of the dark conductivity and the photo conductivity performance as solar cells and the spectral response of junction devices. The effects observed for the a-Si(H) and its alloyw with C or Ge are discussed. Chemical analyses of the alloyed compositions was performed by electron microprobe techniques, and the hydrogen content and the hydrogen evolution spectrum of the base-line a-Si(H) material were measured. (WHK)

25566 (DOE/ET/23005—T4) **Emerging materials systems for solar cell applications - CU/sub 2-x/Se. Final report, Mav 1, 1979-April 30, 1980.** Mickelsen, R.A.; Stewart, J.M.; Chen, W.S. (Boeing Aerospace Co., Seattle, WA (USA)). Apr 1980. Contract AC04-79ET23005. 37p. NTIS, PC A03/MF A01.

The objective of this research program was the investigation of copper selenide (Cu/sub 2-x/Se) films as a promising potential semiconductor material for low cost, mass produced thin film photovoltaic solar cells. Major activities during this program have been the development of the semiconductor film formation process, characterization of the deposited films, calculation of the projected cell performance from theoretical analysis, and the fabrication and testing of simple cell structures. Progress is reported.

25567 (DOE/ET/23013—T4) **Controlled cadmium telluride thin films for solar cell applications. Emerging materials systems for solar cell applications. Quarterly progress report No. 2, July 9-October 8, 1979.** Vedam, K. (Pennsylvania State Univ., University Park (USA). Materials Research Labs.). Nov 1979. Contract AC04-79ET23013. 31p. NTIS, PC A03/MF A01.

Numerous cadmium telluride films with excess Cd or Te have been prepared by controlled rf sputtering technique and characterized. It is found that slight excess of Cd or Te affects the structure, as well as the electrical resistivity of the film, markedly. Ohmic contacts with fairly low contact resistance have been achieved on Cd-rich specimens.

25568 (DOE/JPL—1012-45) **Federal policies to promote the widespread utilization of photovoltaic systems. Supplement: review and critique.** Smith, J.L. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Apr 1980. Contract EX-76-A-29-1012. 120p. NTIS, PC A06/MF A01.

This document is intended as a supplement to the two-volume report entitled Federal Policies to Promote the Widespread Utilization of Photovoltaic Systems that was submitted to Congress by the Department of Energy in February and April of 1980. This supplement contains review comments prepared by knowledgeable experts who reviewed early drafts of the Congressional report. Responses to the review comments by the Jet Propulsion Laboratory, preparer of the Congressional report, are also included in this supplement. The Congressional report, mandated in the Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978 (P.L. 95-590), discusses various issues related to promoting the deployment of photovoltaic systems through the Federal Photovoltaic Program. Various program strategies and funding levels are examined.

25569 (DOE/JPL/954331—80/10) **Silicon materials task of the low-cost solar array project (Phase IV): effects of impurities and processing on silicon solar cells. Eighteenth quarterly report, January 1980-March 1980.** Hopkins, R.H.; Davis, J.R.; Rohatgi, A.; Campbell, R.B.; Rai-Choudhury, P.; Hanes, M.H.; Mollenkopf, H.C.; McCormick, J.R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Apr 1980. Contract NAS-7-100-954331. 53p. NTIS, PC A04/MF A01.

The overall objective of this program is to define the effects of impurities, various thermochemical processes, and any impurity-process interactions upon the performance of terrestrial solar cells. The results of the study form a basis for silicon producers, wafer manufacturers, and cell fabricators to develop appropriate cost-benefit relationships for the use of less pure, less costly solar grade silicon. Fifteen 4 ohm-cm p-type ingots were grown during this quarter, both single crystal and polycrystal, to initiate the Phase IV effort. These ingots were evaluated through electrical measurements, spark source mass spectroscopy, and atomic absorption spectroscopy of the melt. Carbon and oxygen concentrations were measured by ir spectroscopy and found to be within normal limits. Cells made from Mo-doped poly material exhibited very low efficiencies. Cells made from vanadium-contaminated polycrystalline Si also showed very low efficiency due to junction shorting effects; however, a few of the cels with lower inclusion densities could be measured. Projections of effective lfe of solar cells containing some specific impurities were made. On the basis of data derived from elevated temperature stressing of solar cell material, it is concluded that cells containing Mo or Ti as impurities will not degrade appreciably during a twenty year period due to impurity aging effects. However, initial data indicate that cells containing Cr, Nb, or Ag degrade more rapidly than Mo or Ti-doped cells, and may not retain useful efficiencies over a twenty year period. (WHK)

25570 (DOE/JPL/954339—80/18) **Evaluation of selected chemical processes for production of low-cost silicon. Phase III. Eighteenth quarterly progress report, January 1-March 31, 1980.** Blocher, J.M. Jr.; Browning, M.F. (Battelle Columbus Labs., OH (USA)). 15 May 1980. Contract NAS-7-100-954339. 25p. NTIS, PC A02/MF A01.

Progress during this report period was marked by the initial operation of the Process Development Unit at about 50% of design capacity with indications that many aspects of the facility operated satisfactorily. However, a downstream constriction, the cause of which is being isolated, led to termination of the run after one-half hour of operation. In the light of observations made during earlier start-up efforts, several modifications of equipment and technique were made for improved operation. Vacuum outgassing experiments (850 to 1100°C, 1 to 256 h) were carried out on miniplant-produced granules containing 360 and 3900 ppMw of zinc in the deposited silicon. Treatment of the data so that it can be extrapolated to the expected product of the Experimental Process System Development Unit awaits development of an appropriate model.

25571 (DOE/JPL/954343—80/19) **Process feasibility study in support of silicon material Task I. Quarterly technical progress report (XIX), March 1-May 31, 1980.** Yaws, C.L.; Li, K.Y. (Lamar Univ., Beaumont, TX (USA). Dept. of Chemical Engineering). Jun 1980. Contract NAS-7-100-954343. 35p. NTIS, PC A05/MF A01.

Analyses of process system properties were continued for chemical materials important in the production of silicon. Major physical, thermodynamic and transport property data are reported for silicon including critical constants, vapor pressure, heat of vaporization, heat of sublimation, heat capacity, density, surface tension, viscosity and thermal conductivity. The property data covers both liquid and solid phases and are reported as a function of temperature for rapid engineering usage. Major efforts in chemical engineering analysis centered on the HSC process (Hemlock Semiconductor Corporation). The approach for the process involves performing initial analysis for DCS production (dichlorosilane) and then performing analysis of polysilicon production from the DCS. For the DCS production, status and progress are reported for primary activities of base case conditions (65%), reaction chemistry (65%), process flowsheet (60%), material balance (50%) and energy balance (40%). Two key features - redistribution reactor relocation and final distillation - are introduced to increase yield of DCS by about 10 to 20%, help insure purity and reduce potential dust (fine particle nucleation) components in the polysilicon feed material. The preliminary flowsheet for DCS production was forwarded to Hemlock Semiconductor Corporation for initial screening and review. Hemlock Semiconductor is in agreement in regards to relocation of the redistribution reactor to increase yield. Additional follow-up review is in progress including boron removal options identified by Hemlock Semiconductor. 166 references.

25572 (DOE/JPL/954527—80/14) **Investigation of test methods material properties, and processes for solar cell encapsulants. Fifteenth quarterly progress report, November 12, 1979-February 12, 1980.** (Springborn Labs., Inc., Enfield, CT (USA)). Mar 1980. Contract NAS-7-100-954527. 35p. NTIS, PC A03/MF A01.

The goal of this program is to identify, evaluate, and recommend encapsulant materials and processes for the production of cost-effective, long-life solar cell modules. Work performed during this quarter included the development of anti-blocking treatments for EVA sheet intended for use as a lamination pottant. Initial evaluation studies were begun on a new pottant compound, polybutyl acrylate, to assess its preparation and handling characteristics. Corrosion studies using a standard salt spray test wre conducted to determine the degree of protection afforded to a number of metals when encapsulated in candidate pottant compounds. Pottants and outer cover candidates were exposed to intervals of accelerated uv stress aging using the RS/4 fluorescent sunlamp. Results are discussed. (WHK)

25573 (DOE/JPL/955567—80/1) **Design, analysis, and test verification of advanced encapsulation system. Triannual report for period ending March 31, 1980.** Allison, K.; Garcia, A.; Minning, C. (Spectrolab, Inc., Sylmar, CA (USA)). Apr 1980. Contract NAS-7-100-955567. 24p. NTIS, PC A02/MF A01.

Two strawman designs have been devised to aid in the development of analytical techniques for evaluating advanced solar cell encapsulation systems designs. The optical model for a multi-layer system in which reflection, absorption, and transmission may occur between layers, was completed and analytically verified. An expression giving the electrical safety criteria for a multi-layer dielectric system has been derived. A thermal analytical analysis program has been developed which will accommodate up to six different material layers for the determination of NOCT. MSC/NASTRAN has been selected as the primary structural analysis computer code. A matrix of materials and properties has been prepared. Work has begun in finding the necessary material properties.

25574 (DSE—4042-1) **Cadmium sulfide-copper sulfide: heterojunction cell research. Quarterly Progress report-1, September 1, 1978-December 1, 1978.** (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Jun 1979. Contract EG-77-C-01-4042. 54p. NTIS, PC A04/MF A01.

The CdS/Cu_2S cell development effort has now shifted to the planar junction cell. It has been shown that this junction gives a higher open circuit voltage than that achieved with the highly textured cell structure. Optical measurements have shown that applying a two-layer anti-reflection coating to the planar cell does not achieve the high photon economy shown by the textured structure. Total reflectance measurements have revealed that this is due to the lack of light trapping in the planar structure. Modified cell designs are now being developed with the planar junction necessary for high open circuit voltage while achieving the necessary light trapping. Work on the (CdZn)S/Cu_2S cell has revealed that cell performance is extremely sensitive to the method of Cu_2S production. Appropriate structural studies have been initiated to identify the underlying reasons. Theoretical analysis and modeling of the current flow in the Cu_2S layer has shown that the conventional one-dimensional analysis can lead to significant errors in interpreting the effects of sheet resistance. A rigorous two-dimensional current analysis is being conducted. The importance of the changes in absorption coefficient of the Cu_2S stoichiometry has been identified and the relation between stoichiometry, resistivity and absorption coefficient derived. On the basis of a review of the encapsulation task in the large scale silicon array program it has been determined that inorganic glasses are probably the only viable encapsulant for a CdS/Cu_2S cell.

25575 (DSE—4042-2) **Cadmium sulfide-copper sulfide: heterojunction cell research. Quarterly Progress report-2, September 1, 1978-December 1, 1978.** (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Aug 1979. Contract EG-77-C-01-4042. 35p. NTIS, PC A03/MF A01.

The development of the planar junction CdS/Cu_2S solar cell has been continued. Experiments have been conducted with varying thicknesses of Cu_2S to determine whether the need for light trapping can be reduced by utilizing thick Cu_2S layers. Further optical analysis of the influence of texturing on light trapping in the cell have been conducted. In Task 2, the development of a (CdZn)S/Cu_2S cell, a major effort has been expended in determining the details of the junction morphology. A wide range of analytical work has continued under Task 3. Preliminary data has been obtained on cells sealed behind sheet glass and cells with integral electron beam evaporated glass coatings.

25576 (DSE—4042-T25) **Indium phosphide/cadmium sulfide thin-film solar cells.** Zanio, K. (Hughes Research Labs., Malibu, CA (USA)). Feb 1980. Contract EG-77-C-01-4042. 21p. NTIS, PC A02/MF A01.

Thin-film InP/CdS structures were prepared by depositing, in sequence, ITO on a low-cost glass substrate, CdS on the ITO by thermal evaporation, and InP on the CdS by planar reactive deposition (PRD). Films of CdS, 15 μm thick, were recrystallized in flowing H_2/H_2S at 500°C. Lateral dimensions of typical grains were 50μm with values up to 200 μm. The sheet resistance of the recrystallized CdS (RXCdS) was lowered from greater than 10^8 $\Omega/O = cm^2$ to values as low as 16 $\Omega/O = cm^2$ by annealing in either H_2 Cd atmospheres. Epitaxy of InP was undertaken on (100) InP at a substrate temperature of 320°C. Room-temperature electron mobilities of about 2000 cm^2/V-sec were found. Mobilities and hole concentrations of 60 cm^2/V-sec and 10^{17} cm^{-3}, respectively, were achieved with Be-doped films. P-type films with hole concentrations as high as a few times $10^{18}cm^{-3}$ were achieved with increased doping. Be-doped InP was deposited onto the RXCdS/ITO/GLASS substrate to form a thin-film cell. However, p-type InP could not be prepared with CdS as a substrat4e, presumably due to interdiffusion or vapor transport of sulfur. Consequently, blocking action and a photovoltage could only be achieved using a gold Schottky barrier on the InP/RXCdS/ITO/GLASS structure. Plans for the next quarter include determining whether n-type doping from the CdS occurs by either interdiffusion or vapor transport, characterizing InP epitaxy on the RXCdS, and preparing additional thin-film structures.

25577 (DSE—4042-T37) **Physical models of thin film polycrystalline solar cells based on measured grain-boundary and electronic-parameter properties. Quarterly report.** Lindholm, F.A.; Fossum, J.G.; Holloway, P.A.; Neugroschel, A. (Florida Univ., Gainesville (USA). Coll. of Engineering). Dec 1979. Contract EG-77-C-01-4042. 40p. NTIS, PC A03/MF A01.

Solar cells fabricated on polycrystalline silicon, either bulk or thin-film, can potentially be cost-effective when used in terrestrial photovoltaic energy-conversion systems. To achieve this goal, the polysilicon cell efficiency must be increased considerably from its present values. A severe limitation to the cell efficiency is due to the grain boundaries and their influence on carrier recombination. To remove this limitation, an understanding of the fundamental physics underlying the effects of the grain boundaries on cell performance is helpful. This fundamental physics is discussed, and models are developed for recombination currents in polysilicon pn-junction solar cells. Several analytic approximations, suggested by physical insight, are used and checked ultimately for self-consistency with the results of the analysis. The models are defined such that their parameters can be related directly to measurements, and the models are hence useful in interpreting experimental results. They also can be used to study, in a systematic way, cell-design modifications to improve the efficiency, e.g., grain-boundary passivation techniques.

25578 (DSE—4042-T38) **Development of high efficiency cascade solar cells. Quarterly technical progress report No. 3.** (Solar Energy Research Inst., Golden, CO (USA)). 31 Mar 1980. Contract EG-77-C-01-4042. 16p. NTIS, PC A02/MF A01.

Progress is reported in the following areas: AlGaAsSb/GaAsSb materials development, GaInP materials development via VPE, GaAlAs/GaAs cell development, and OM/CVD studies. Spectral response, V-I characteristics, and electron microprobe analysis results are presented. (WHK)

25579 (DSE—4042-T40) **Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 2, 1 December 1979-29 February 1980.** Zehr, S.W.; Yang, H.T.; Yang, J.J.; Harris, J.S. Jr. (Rockwell International Corp., Thousand Oaks, CA (USA). Science Center; Rockwell International Corp., Anaheim, CA (USA). Electronics Research Div.). 1980. Contract AC02-77CH00178. 31p. NTIS, PC A03/MF A01.

This report describes second quarter activities for a project aimed at demonstrating the technical feasibility of advanced high efficiency concentrator solar converters. The goal of the program is to achieve 30% conversion efficiency with a converter operating at 30°C under 500 to 1000 SUN AM2 illumination and 25% conversion efficiency with a converter operating at 150°C under 500 to 1000 SUN AM2 illumination. The approach is to fabricate two cell, nonlattice matched, monolithic stacked converters using optimum pairs of cells having bandgaps in the range of 1.6 to 1.7 eV and 0.95 to 1.1 eV. The high bandgap cells are to be fabricated using MOCVD or LPE to produce the needed AlGaAs layers of optimized composition, thickness and doping to produce high performance, heteroface homojunction devices. The low bandgap cells are to be similarly fabricated from AlGaSb(As) compositions by LPE. These subcells are then to be joined into a monolithic structure by an appropriate thermal bonding technique which will also form the needed transparent intercell ohmic contact (IOC) between the two subcells. The activities this quarter have been largely focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation.

25580 (SAN—0113/40-3) **Low cost solar cells based on amorphous silicon electrodeposited from organic solvents. Final technical report, September 1, 1978-August 31, 1979.** Kroeger, F.A. (University of Southern California, Los Angeles (USA). Dept. of Materials Science). 1979. Contract EY-76-S-03-0113-040. 34p. Dep. NTIS, PC A03/MF A01.

A variety of silicon compounds were chosen for electrolysis experiments viz, silicon tetrachloride, silicon tetrabromide, tetraethylorthosilicate, potassium hexafluoro silicate and ammonium hexafluoro silicate. These compounds are dissolved in non-aqueous solvents, acetone, acetic acid, ethylene glycol, propylene glycol, propylene carbonate, pyridine, ethylene diamine, 1-chloropropane, formamide, N-Ndi methyl formamide etc. Where the conductivity of the solutions is low, supporting electrolytes like tetrabutyl ammonium chloride, bromide or perchlorate were added. The electrolysis was carried out using, silicon nickel, conducting glass, stainless-steel or copper cathodes, graphite, platinum or silicon anodes and saturated calomel or Ag/AgCl as reference electrodes. The silicon coatings obtained by electrolysis vary in colour between white and black with greyish white, light or dark brown as intermediate colors the color obtained depending on the electrolysis conditions. Energy dispersive x-ray analysis in the scanning electron microscope indicated the coatings to contain large concentrations of silicon; infrared absorption and reflection studied showed bands characteristic of Si-O, Si-Cl or Si-F vibrations, and thus indicates the presence of these elements in the films. No Si-H bands were observed. Doping reagents were added to the electrolyte and a-Si coatings doped with phosphorus or boron were obtained. These were tested by hot point probe for the thermoelectric carrier type. The electrical resistance of the coatings was determined by measuring the potential drop when the electrolysis was interrupted as a function of film thickness. Procedures and results are reported. (WHK)

25581 (SAN—0113-040-T6) **Low cost solar cells based on amorphous silicon electrodeposited from organic solvents. Final technical report, September 1, 1978-August 31, 1979.** Kroeger, F.A. (University of Southern California, Los Angeles (USA). Dept. of Materials Science). 1979. Contract EY-76-S-03-0113-040. 34p. NTIS, PC A03/MF A01.

The purpose of the work on this contract is to prepare thin film amorphous silicon by electrodeposition fom silicon compounds in organic solvents for use in solar cells. A variety of silicon compounds are chosen for electrolysis experiments viz, silicon tetrachloride, silicon tetrabromide, tetraethylorthosilicate, potassium hexafluoro silicate and ammonium hexafluoro silicate. These compounds are dissolved in non-aqueous solvents, acetone, acetic acid, ethylene glycol, propylene glycol, propylene carbonate, pyridine, ethylene diamine, 1-chloropropane, formamide, N-Ndi methyl formamide etc. Where the conductivity of the solutions is low, supporting electrolytes like tetrabutyl ammonium chloride, bromide or perchlorate are added. The electrolysis was carried out using, silicon nickel, conducting glass, stainless-steel or copper cathodes, graphite, platinum or silicon anodes and saturated calomel or Ag/AgCl as reference electrodes. Energy dispersive x-ray analysis in the scanning electron microscope indicated the coatings to contain large concentrations of silicon; infrared absorption and reflection studied showed bands characteristic of Si-0, Si-Cl or Si-F vibrations, and thus indicates the presence of these elements in the films. No Si-H bands were observed. Doping reagents were added to the elctrolyte and a-Si coatings doped with phosphorus or boron were obtained. There were tested by hot point probe for the thermoelectric carrier type. The electrical resistance of the coatings was determined by measuring the potential drop when the electrolysis was interrupted as a function of film thickness. (WHK)

25582 (SAND—78-1962) **Analytical evaluation of a solar thermophotovoltaic converter.** Edenburn, M.W. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 31p. NTIS, PC A03/MF A01.

A solar thermophotovoltaic (TPV) converter uses concentrated sunlight to heat a cavity-enclosed emitter to a few thousand degrees kelvin. The emitter illuminates photovoltaic cells with thermal radiation, and the cells convert the radiation into electricity. This report presents an analysis of the TPV converter so that the practicality of its future development can be addressed. The analysis parametrically considers emitter temperature, cell reflectance to radiation with energy below the cell's bandgap energy, and concentration ratio requirements. Concentration ratio is treated in a rigorous manner to determine what concentration values can be practically achieved and what influence they have on converter performance. Important conclusions reached are that an emitter temperature of 2000 K is close to optimum and a cell reflectance value of 0.98 is required for below bankgap radiation. A secondary concentrator must be used and a primary mirror quality resulting in a 4-milliradian reflected-beam dispersion must be obtained to achieve a 24% conversion efficiency.

25583 (SAND—80-0879) **Fundamental studies of grain boundary passivation in polycrystalline silicon with application to improved photovoltaic devices. A final research report covering work completed from February-December 1979.** Seager, C.H.; Ginley, D.S. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1980. Contract AC04-76DP00789. 118p. NTIS, PC A06/MF A01.

Several aspects of the electrical properties of silicon grain boundaries have been studied. The temperature dependence of the zero-bias conductance and capacitance of single boundaries has been measured and shown to be in good agreement with a simple double depletion layer/thermal emission (DDL/TE) model developed to predict the transport properties of such structures. In addition, it has been shown that deconvolution of the I-V properties of some boundaries via a deconvolution scheme suggested by Pike and Seager yields effective one-electron densities of trapping states which are in good agreement with estimates obtained by low temperature electron emission measurements. Experiments have also been performed which indicate that diffusion of atomic hydrogen into silicon grain boundaries greatly reduces this density of trapping states. In properly prepared, large grained polycrystalline samples all measurable traces of grain boundary potential barriers can be removed to substantial penetration depths after several hours exposure to a hydrogen plasma at elevated temperatures. Initial experiments on prototype polysilicon solar cells have shown that this passivation process can improve AM1 efficiencies. In order to more fully understand and develop this process for improving practical multigrained cells, several device research efforts with other DOE/SERI funded contractors have been initiated.

25584 (SAND—80-7008) **Terrestrial photovoltaic power systems with sunlight concentration.** Backus, C.E.; Wood, B.D. (Arizona State Univ., Tempe (USA). School of Engineering). Mar 1980. Contract EY-76-C-04-0789. 191p. Dep. NTIS, PC A09/MF A01.

A detailed account of research at Arizona State University on all aspects of photovoltaic concentration systems during 1978 is given. The development of testing equipment and test results of manufactured concentrator cells are reported. Most of the data was taken using the 1.08 meter diameter fresnel lens. Experiments were conducted on the flux uniformity and spectral distribution in the concentrated sunlight under the lens. The preliminary data from these experiments show that the short circuit currents from a cell are directly proportional to the total illumination falling on the surface of the cell and not on the uniformity of the light profile. A theoretical analysis was performed on the effects of high injection levels for different types of surface states and models of surface recombination and the resulting effects on the surface recombination velocity. Results indicate that the surface recombination velocity increases with injection level. The investigation on the concept of using multiple cells in a concentrated sunlight to increase efficiency was continued. An available gallium aluminum arsenide cell was used with a hot mirror and a silicon cell to demonstrate that the efficiency of the combined system is greater than that achievable with the use of a single cell. As an aid to system designers, a complex algorithm for calculating the electrical and thermal performance of a linear concentrated cell array has been developed. This computer program, based on quasi-steady state analysis, will calculate the array temperature and electrical outputs based on the day, time, transfer fluid inlet temperature and flow rate, ambient temperature, wind speed and direction, optical characteristics of the linear concentrator and solar irradiation. (WHK)

25585 **Integrated solar cell array.** Chiang, S.Y.; Carbajal, B.G. (to Texas Instruments Inc.). US Patent 4,173,496. 6 Nov 1979. Filed date 30 May 1978. 4p.

An integrated, monolithic array of solar cells is described wherein isolation between cells permits series interconnection of the cells to provide an output voltage for the array equal to the sum of the voltages of the unit cells. Although normal PN junction isolation is ineffective when exposed to light, the present structure includes a form of junction isolation that is effective when exposed to light, or to other radiation. For example, a band of heavily doped P-type silicon, formed by thermomigration of aluminum through an N-type wafer, provides such isolation. 4 claims.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 25455, 25460, 25462, 26384

25586 (DOE/CS/40049—1) **Recovery of anaerobic digestion after exposure to toxicants. Final report.** Yang, J.; Parkin, G.F.; Speece, R.E. (Drexel Univ., Philadelphia, PA (USA)). Dec 1979. Contract EC-77-S-02-4391. 170p. NTIS, PC A08/MF A01.

The concept that methane fermentation cannot tolerate chronic or slug doses of toxicants has almost totally precluded methane fermentation as a viable contender for the treatment of industrial wastewaters. This study assayed a wide variety of toxicants, heavy metals, inorganic salts, organic chemicals, solvents, and antibiotics which are used in industrial processes and, therefore, appear in the industrial wastewaters therefrom. Toxicity was related to the reduction in methane production of a control containing no toxicant. The response of methane fermentation after exposure to a toxicant was assayed with unacclimated cultures as well as cultures which had been acclimated to increasing concentrations of the toxicant over long periods of time. The reversible nature of the toxicants was assayed by adding slug doses to plug flow anaerobic filters and recording gas production prior to, during, and after toxicant addition.

25587 (DOE/ET/14696—T1) **Peat biogasification development program. Quarterly progress report No. 1, October 1-December 31, 1979.** (Dynatech R/D Co., Cambridge, MA (USA)). 1979. Contract AC01-79ET14696. 28p. NTIS, PC A03/MF A01.

Batch experiments have been performed to determine the effects of different alkalis, temperatures, and oxygen partial pressures on the solubility of peat organic material. Multi-stage pretreatment was investigated by pretreating the effluent from previous NaOH pretreatment cooks. Bacteria from three inoculation sources are being grown anaerobically on a growth medium containing a standard nutrient medium and one of twelve aromatic compounds. The concentration of aromatic compound is increased gradually to acclimate the bacteria to compounds which may result from peat pretreatment. These bacteria are being prepared for future digestion of pretreated peat. Laboratory procedures to determine pretreated solids energy content and pretreated solids dewatering characteristics are being developed. The environmental effects of liquid effluent disposal into the peat bog is being evaluated through a review of relevant literature. A preliminary design for a full scale peat biogasification plant has been developed. The plant is designed to produce 75 x 10^6 SCFD of pipeline quality methane. Major segments of the plant are concerned with the transport, handling, pretreating, and fermenting of the aqueous peat slurry, and the purification of the resulting methane gas. The information necessary for continuous PDU scale operation is being evaluated as part of Task 4. A detailed proposal for specific design plans and experiments has not yet begun yet, however.

25588 (DOE/ET/23124—T1) **Preliminary screening of woody plants as biomass crops on energy farms. Final report.** (Ultrasystems, Inc., McLean, VA (USA)). 7 Dec 1979. Contract AP01-79ET23124. 43p. NTIS, PC A03/MF A01.

The results of a research project to perform a preliminary screening of woody plants as biomass crops on energy farms are described. An idealized model of a biomass crop, constructed out of physiologic and ecologic traits of woody plants, was developed for screening candidates. Nearly a hundred woody plants were screened yielding twenty-four likely candidates. The twenty-four candidates were aggregated by biogeographic criteria into five groups and mapped accordingly.

25589 (DSE—3992-T1) **Economic evaluation of the MIT process for manufacture of ethanol.** Jenkins, D.M.; Reddy, T.S. (Battelle Columbus Labs., OH (USA)). 28 Jun 1979. Contract ET-78-X-01-3992. 32p. NTIS, PC A03/MF A01.

This report summarizes the results of an economic evaluation of the MIT process for the manufacture of ethanol from cellulosic residues. Conceptual process designs were developed for two cases, Case A which is based on the experimental data obtained to date, and Case B which hypothesizes the suppression of acid byproducts. Manufacturing costs, including profit, were estimated at $12.20/million Btu for Case A and $9.40/million Btu for Case B. These are equivalent to about $1.05 and $0.80/gal ethanol respectively. These economic estimates may be slightly on the low side since they do not consider feedstock storage nor working capital requirements. Nevertheless, the manufacturing costs for Case A appear to be comparable to those of the manufacture of ethanol from corn. The plant size used for this analysis was 1500 ton/day corn stover. This is considered to be a realistic size. The conceptual plants make about 27 million gal/yr ethanol in Case A and 41 million gal/yr in Case B. The MIT process appears to be one of the more promising programs being developed under contract for DOE. It is recommended that the process research be continued. Three areas of concern were identified which must be investigated before the process can be commercialized. First, a satisfactory means of storage of corn stover and other agricultural residues must be developed. Second, a method to sterilize corn stover must be developed or it must be demonstrated that the MIT process can run continuously for extended periods with stover that has been sterilized. Third, research must be done to demonstrate the recycle and reuse of process water.

25590 (LBL—9789) **Liquid fuels from biomass: catalysts and reaction conditions.** Seth, M.; Ergun, S.; Vermeulen, T.; Djafar, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 72p. NTIS, PC A04/MF A01.

The use of α-phellandrene as a hydrogen transfer agent in wood liquefaction was studied at 200°C. No significant thermally promoted hydrogen transfer occurred under these conditions. Dilute sulfuric acid was added to test the possibility of hydride transfer from α-phellandrene to wood. Extensive solvent alkylation of the wood occurred in the presence of up to 2 wt % of sulfuric acid. Addition of palladium as a hydrogenation catalyst resulted in lower overall conversion based on the toluene-insoluble residue obtained, and in lowered levels of solvent alkylation. Several inorganic salts were tested as catalytic additives for wood liquefaction at 250°C in the presence of tetralin as a possible hydrogen donor. No hydrogen transfer from the solvent was observed. About 50% by weight of the wood was converted to gases and toluene and water extractable materials in the absence of an additive. Of the additives tested, nickel chloride, sodium carbonate, and ferric chloride resulted in wood conversions greater than or equal to those obtained in the absence of an additive. Toluene extraction was used as a measure of oil yield. Of the additives tested, ferric chloride resulted in the highest yield of toluene solubles with about 28 wt % of the wood being converted to oil. Atomic H/C ratios of the toluene extracts ranged from 1.51 to 0.85 compared to 1.21 for untreated wood. The O/C ratios of the toluene extracts ranged from 0.18 to 0.44 compared to an O/C ratio of 0.57 for untreated wood. Nuclear magnetic resonance spectroscopy indicated that the toluene soluble fraction of the products contained benzylic, phenolic, and alcoholic protons. Ultraviolet spectra indicated the presence of carbonylic and aldehydic groups.

25591 (LBL—10800) **Hemicellulose utilization for ethanol production.** Rosenberg, S.L.; Batter, T.R.; Blanch, H.W.; Wilke, C.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 29p. (CONF-800802—5). NTIS, PC A03/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

As much as a third of the carbohydrate content of some forms of cellulosic biomass resides in the hemicellulose fraction. Pentosans are major constituents of this material, the most common sugar being D-xylose. As part of a larger program for the bioconversion of cellulose to ethanol, the fermentation of pentose sugars to ethanol is being studied. Two microorganisms have been examined. The mold Fusarium oxysporum (lini) ferments D-xylose to near theoretical yields of ethanol but grows too slowly to be currently economical. The bacterium Bacillus macerans gives somewhat lower yields of ethanol from D-xylose but grows much faster. With further stdy this organism may form the basis for an economical hemicellulose fermentation process.

25592 (ORNL/MIT—309) **Response of a packed-bed, fixed-film bioreactor to zinc toxicant.** Amrhein, M.; Ngan, F. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

An anaerobic, upflow bioreactor was fed a zinc chloride and nutrient solution, and the response of the bioreactor was monitored over a two-week period. The main objectives of this project were to assess the biological performance of the bioreactor in response to zinc toxicant and to determine the capability of the column for zinc removal. A step-input of Zn^{++} (100 mg/l) was added to a synthetic waste being fed to a bench-scale unit at a superficial velocity of 0.034 cm/min. This column, which had previously been operating at steady-state conditions, was operated simultaneously with an identical column to which Zn^{++} had not been added. The test was conducted for 320 h, or five hydraulic residence times. More than 95% of the zinc entering the column was removed by the reactor. Inhibition of anaerobic processes, including gas production, was noted, but the bioreactor was apparently retuning to the expected

performance level toward the end of the two-week testing period. Zinc accumulated mostly in lower regions of the bioreactor, with biological processes decreasing in that region but shifting to higher regions in the column after a delay period. The tolerance level of the column to zinc could not be estimated during the relatively short testing period.

25593 (ORO—5912-T3) **Production of sugarcane and tropical grasses as a renewable energy source. First and second quarterly reports, 1979-1980.** Alexander, A.G.; Allison, W.; Garcia, M. (Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station). 1979. Contract ET-78-S-05-5912. 73p. NTIS, PC A05/MF A01.

Research continued on tropical grasses from Saccharum and related genera as sources of intensively-produced fiber and fermentable solids. Completed data on the first-ratoon crop (year 2) for sugarcane and napier grass were compiled. The principal yield trends for biomass included: (a) increased yields with delay of harvest frequency; (b) lack of response to narrow row spacing; and (c) lack of appreciable yield differences between varieties when allowed to reach maturity. First-ratoon yields for both sugarcane and napier grass significantly exceeded the plant-crop yields. For sugarcane, the average production of millable cane was 88.6 tons/acre year. Production costs for sugarcane amounted to $25.46/oven-dry ton, or about $1.70/million Btus. Sucrose yields were quite low, averaging 6.6%, but total fermentable solids were comparable to the commercial sugarcane yields in Puerto Rico. At 80% extraction, the yield of fermentable solids from the average cane herein described would amount of 10.5 tons/acre. Its value today if marketed as high-test molasses would be in the order of $1500 to $2000/acre. Additional progress in candidate screening, breeding for biomass attributes, and economic studies is discussed.

25594 (SERI/RR—624-669R) **Preliminary energy balance and economics of a farm-scale ethanol plant.** Jantzen, D.; McKinnon, T. (Solar Energy Research Inst., Golden, CO (USA)). May 1980. Contract EG-77-C-01-4042. 14p. NTIS, PC A02/MF A01.

The energy balance and economics of grain to ethanol plants are matters of current national interest, as we strive to deal with our liquid fuel supply problems. This report prepared at the request of the Department of Energy, examines the energy balance and economic questions for a particular farm-scale plant in Campo, Colo. It shows that such plants may have a place in our national liquid fuel supply system.

25595 (SERI/TR—33-239(Vol.3)) **Survey of biomass gasification. Volume III. Current technology and research.** (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 302p. NTIS, PC A14/MF A01.

This survey of biomass gasification was written to aid the Department of Energy and the Solar Energy Research Institute Biological and Chemical Conversion Branch in determining the areas of gasification that are ready for commercialization now and those areas in which further research and development will be most productive. Chapter 8 is a survey of gasifier types. Chapter 9 consists of a directory of current manufacturers of gasifiers and gasifier development programs. Chapter 10 is a sampling of current gasification R and D programs and their unique features. Chapter 11 compares air gasification for the conversion of existing gas/oil boiler systems to biomass feedstocks with the price of installing new biomass combustion equipment. Chapter 12 treats gas conditioning as a necessary adjunct to all but close-coupled gasifiers, in which the product is promptly burned. Chapter 13 evaluates, technically and economically, synthesis-gas processes for conversion to methanol, ammonia, gasoline, or methane. Chapter 14 compiles a number of comments that have been assembled from various members of the gasifier community as to possible roles of the government in accelerating the development of gasifier technology and commercialization. Chapter 15 includes recommendations for future gasification research and development.

25596 (SERI/TR—353-513) **Costs of using crop residues in direct combustion applications.** Flaim, S.; Urban, D. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 52p. NTIS, PC A04/MF A01.

The economic feasibility of burning crop residues for on-farm grain drying, grain drying at a grain elevator, and electricity generation at a utility are examined. Following dramatic price increases for petroleum during 1979, grain drying is the most economically attractive alternative studied. For on-farm applications, a typical 400-acre grain harvest would consume nearly 5,500 gallons of propane to dry 52,000 bushels of corn from 22% moisture content wet basis (MCWB) to 15% MCWB. Fuel savings from using crop residues instead of propane amount to nearly $2,080 for a typical 8-day harvest. Since one grain elevator services many customers, the front-end capital costs of a residue burner cane spread over a larger harvest. The fuel savings over propane for grain elevators amount to nearly $27,400 per year - approximately the cost of the drying equipment (bin excluded). The cost of using crop residues in utility aplications are prohibitive if the average cost of coal for utilities is used for comparison. The potential use of crop residues as a utility boiler fuel is much greater than grain drying, but relative costs depend on the specific characteristics of each application and on the accessibility and cost of coal.

25597 **Biogas technology in the third world: a multidisciplinary review.** Barnett, A.; Pyle, L.; Subramanian, S.K. Ottawa, Canada; International Development Research Center (1978). 132p. (IDRC—103e).

In response to the interest in biogas and other rural energy systems shown by a number of Asian researchers, the International Development Research Centre commissioned this state-of-the-art review so that it might form a basis of further discussions concerning the direction of future biogas research. This book, which is divided into three chapters, represents a multidisciplinary approach to the problem and attempts to review existing work rather than to champion particular solutions. The first chapter establishes in broad terms the energy options facing rural communities in the Third World and considers in detail just what is known about the technical aspects of biogas production. This is done by assembling details of known small-scale digester designs and by reviewing the literature to establish the technical parameters determining digester performance. A microapproach to the social and economic appraisal of rural technologies, which stresses both the need to examine technologies in their social context and the need to compare biogas investments with alternative uses of the resources available in specific rural locations, is presented in the second chapter. This approach is discussed in relation to a number of the better attempts that have been made to evaluate biogas. The third chapter complements the other two by presenting practical field experience. It is based on an extensive survey of a large number of biogas plants and their supporting infrastructure in India, Thialand, Indonesia, the Philippines, South Korea, and Japan.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 25448

25598 (IS—4724) **Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides. Technical progress report, first quarter, year one.** (Ames Lab., IA (USA)). Feb 1980. Contract W-7405-ENG-82. 20p. NTIS, PC A02/MF A01.

Successful growth of WSe_2 crystals has led to the production of photocells which operate with greater than 5% monochromatic power converson efficiency in I^-/I_3 solution. Scanning light spot maps were used to identify and evaluate inhomogeneities across the surface and to serve as a reference for the edge passivation program which already has helped improve performance significantly. Results are discussed.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 25568, 25611

25599 (DOE/ER—0051) **Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies.** Wolsko, T.; Buehring, W.; Cirillo, R.; Gasper, J.; Habegger, L.; Hub, K.; Newsom, D.; Samsa, M.; Stenehjem, E.; Whitfield, R. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 79p. Dep. NTIS, PC A05/MF A01.

A description of the initial methodology for the Comparative Assessment of the Satellite Power System Concept Development and Evaluation Program of NASA and DOE is presented. Included are study objectives, issue identification, units of measurement, methods, and data bases. The energy systems concerned are the satellite power system, several coal technologies, geothermal energy, fission, fusion, terrestrial solar systems, and ocean thermal energy conversion. Guidelines are suggested for the characterization of these systems, side-by-side analysis, alternative futures analysis, and integration and aggregation of data. The bulk of this report is a description of the methods for assessing the technical, economic, environmental, societal, and institutional issues surrounding the development of the selected energy technologies.

25600 (SAND—79-7054) **Photovoltaic institutional issues study.** Watkins, G.A.; Noel, G.; Hagely, J.; Broehl, J.; Duchi, M.; Smail, H.; Martineau, T.; Maiden, B. (Battelle Columbus Labs., OH (USA)). Apr 1980. Contract AC04-76DP00789. 223p. NTIS, PC A10/MF A01.

The significance of institutional issues to the development of photovoltaics is presented for four issue areas: codes, ordinances and standards; financial and taxation; insurance and liability; and, environmental and other issues. The key institutional issues are presented in the context of nine prototypical systems, designed to reflect institutional issue variation. Key institutional issues associated with

each of the aforementioned issue areas are explored to demonstrate their relevance to application of photovoltaics. Programmatic recommendations are made which could serve to address institutional issues identified. Also included are opportunities for those persons, agencies and governmental entities involved in the commercialization and widespread use of photovoltaics to address the institutional issues identified. (WHK)

25601 (SAND—80-7010) **Residential photovoltaic systems: a review and comparative evaluation of four independent studies of potential concepts.** Finlayson, F.C. (Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.). Apr 1980. Contract AC04-76DP00789. 75p. NTIS, PC A04/MF A01.

Four independent studies of residential applications of photovoltaic generating systems were recently conducted by major industrial contractors: General Electric, Westinghouse, MIT-Lincoln Labs, and The Aerospace Corporation. The conclusions of the contractors had a number of important similarities and differences. An analysis of the several contractor's results, together with an identification of the sources of their similarities and differences is presented.

25602 (SERI/TP—245-430, pp 179-182) **Combined solar thermal/photovoltaic system: cooling system.** Darkazalli, G.; Lawley, L.J.; Kugle, S. (Univ. of Texas, Arlington). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The University of Texas at Arlinton's Solar Energy Research Facility (UTA/SERF), under contract with the Massachusetts Institute of Technology-Lincoln Laboratory, has added a 110 square meter 8 kw/sub pk/ photovoltaic system to its solar thermal experiment. Electricity from the 8 kw/sub pk/ photovoltaic system is used to supply the electric demands of the UTA/SERF 145 m^2 (1550 ft^2) test residence. A series water-to-water heat pump is used to chill a cold water storage tank in accordance with the time of day metering rates. Excess photovoltaic energy is fed back to the utility during peak demand hours. A 55 square meter (590 ft^2) flat-plate solar thermal collector system is used for domestic hot water preheat and space heating. Preliminary results from the first year operation of the combined system is presented.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 25760, 25810, 25811, 25812, 25813, 25814

25603 **Therma motor.** Kandarian, R. US Patent Application 061,150. [nd]. 6p.

The disclosure is directed to a thermal motor utilizing two tapered prestressed parallel adjacent cylinders lengthwise disposed about one third in a coolant. Heat is applied to contacting portions of the cylinders outside the coolant to cause them to deform and turn. Heat sources such as industrial waste heat, geothermal hot water, solar radiation, etc. can be used.

25604 (DOE/JPL—1060-33, pp 153-158) **Cost estimating Brayton and Stirling engines.** Fortgang, H.R. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Brayton and Stirling engines were analyzed for cost and selling price for production quantities ranging from 1000 to 400,000 units per year. Parts and components were subjected to indepth scrutiny to determine optimum manufacturing processes coupled with make or buy decisions on materials and small parts. Tooling and capital equipment costs were estimated for each detail and/or assembly. For low annual production volumes, the Brayton engine appears to have a lower cost and selling price than the Stirling engine. As annual production quantities increase, the Stirling becomes a lower cost engine than the Brayton. Both engines could benefit - cost wise - if changes were made in materials, design and manufacturing process as annual production quantities increase.

25605 (DOE/JPL—1060-33, pp 185-189) **SPS market analysis.** Goff, H.C. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Advanced Energy Department of General Electric is performing a study for JPL on the Effects of System Factors on the Economics of and Demand for Small Solar Thermal Power Systems (SPS). Study goals are to estimate market penetration as a function of time, SPS performance factors, and market/economic considerations, and to formulate commercialization strategies. A market analysis task has included personal interviews by GE personnel and supplemental mail surveys to acquire statistical data and to identify and measure attitudes, reactions and intentions of prospective SPS users. Over 500 firms were contacted, including three ownership classes of electric utilities, industrial firms in the top SIC codes for energy consumption, and design engineering firms. A market demand model was developed which utilizes the data base developed by personal interviews and surveys, and projected energy price and consumption data to perform sensitivity analyses and estimate potential markets for SPS.

25606 (DOE/JPL—1060-33, pp 191-195) **Military markets for solar thermal electric power systems.** Hauger, J.S. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The Department of Defense (DOD) is the single largest consumer of engine driven generators. Its procurement is responsive to factors other than first cost. Its non-combat applications are similar to the general market for non-grid power systems which is estimated to be over 2000 MW/year in the US and 28,000 MW/year worldwide. The DOD maintains an inventory of over 1800 MW of engine-generators 15 KW and larger, with an estimated procurement rate of over 140 MW/year. Most current systems are diesel driven, but nearly the entire requirement could be met by advanced heat engines of the types being developed as point-focussing, distributed receiver power plants. A conceptual system consisting of a heat engine which efficiently burns liquid fossil or synthetic fuels, with a solarization kit for conversion to hybrid solar operation could meet existing DOD requirements for new systems which are quieter, lighter, and multi-fueled. An estimated 24% (33 MW/year) or more could operationally benefit from the solar option. Baseline cost projections indicate levellized energy cost goals of 210 to 120 mills/KWh (15 to 1000 KW systems). Fuel cost escalation is the major factor affecting the value of the solar option. A baseline calculation for fuel at $0.59/gal in spring, 1979, escalating at 8% above general inflation indicates a value of $2700/KWe for a solarization kit.

25607 (DOE/JPL—1060-33, pp 197-209) **Solar thermal plant impact analysis and requirements definition.** Gupta, Y.P. (Science Applications, Inc., McLean, VA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Progress on a continuing study comprising ten tasks directed at defining impact and requirements for solar thermal power systems (SPS), 1 to 10 MWe each in capacity, installed during 1985 through year 2000 in a utility or a non-utility load in the United States is summarized. The prime emphasis is on the Point Focus Distributed Receiver (PFDR) solar power systems. Tasks 1 through 4, completed to-date, include the development of a comprehensive data base on SPS configurations - their performance, cost, availability, and potential applications; user loads; regional characteristics; and an analytic methodology that incorporates the generally accepted utility financial planning methods and several unique modifications to treat the significant and specific characteristics of solar power systems deployed in either central or distributed power generation modes.

25608 (DOE/JPL—1060-33, pp 211-215) **Study of mass production and installation of small solar thermal electric power systems.** Butterfield, J. (Arthur D. Little, Inc., San Francisco, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

This study of concentrating collector industrialization included technological constraints, materials availability, production capacity, and manufacturing and installations plans and costs at different production levels. Several constraints were identified. Cobalt, for the engine and receiver, is supply limited. Alternative lower temperature alloys and higher temperature materials (ceramics) are discussed. Economics and production efficiency favor co-location of cellular and thin glass production for reflectors. Assembly and installation are expensive for small sites and few alternatives exist to apply mass production techniques to lower these costs for the selected design. Stepping motors in the size and quantities required are not commercially available today but could be in the future. The study concluded that additional development should be concentrated on design modification to permit industrialization of the assembly and installation process, the use of alternative materials in the engine/receiver subsystem, the design of motors and gearboxes matched to concentrator requirements, and development of an integrated process for reflector production.

25609 (LBL—9750) **Efficiency of energy conversion in Nitinol.** Kopa, R.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 77p. (CONF-7809211—1). NTIS, PC A05/MF A01.

From Nitinol heat engine conference; Silver Spring, MD, USA (26 Sep 1978).

Nitinol - one of several Shape Memory Effect (SME) alloys - is known to be a suitable medium for the conversion of heat to usable mechanical work in a solid state heat engine. In the present study, the efficiency of the energy conversion in Nitinol is investigated experimentally. An electronically controlled Cycle Simulator subjects a single Nitinol wire element to the stress-strain-temperature cycles corresponding to a specific thermodynamic cycle (e.g., con-

stant-strain isothermal, stress-limited isothermal, constant-stress isothermal, semi-adiabatic, etc.), as selected during the investigation. The test parameters, which are varied singly or in combination, include various stress levels, stress rates, percent of elongation of the wire, temperature levels, heating and cooling rates, cycling speeds, etc. Efficiency values as a function of these variables are plotted in graphs and the factors affecting efficiency are discussed. The highest thermodynamic efficiency thus far determined is 1.2 percent (approximately 6 percent of Carnot efficiency), with a concomitant Nitinol wire life expectancy on the order of 10^4 cycles. However, these values are not regarded as the highest attainable. The fundamental limitation of the energy conversion efficiency is set by the inefficient type of thermodynamic cycle - namely, the isothermal cycle - to which the solid state heat engine operation is restricted. The reasons for this restriction are discussed. The simple constant-strain isothermal cycle is analyzed and described in stress-strain coordinates and in a T-S diagram. An analytic expression for the calculation of the energy conversion efficiency is presented, along with experimental investigation of the proposed postulates. A few preliminary investigations of various approaches to efficiency improvement are reported, and one promising research area is suggested.

25610 (SERI/TR—98366-1) **Evaluation techniques for determining the reflectivity, specularity, and figure of solar mirrors.** Griffin, J.W.; Lind, M.A.; Philipp, L.D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EG-77-C-01-4042. 110p. NTIS, PC A06/MF A01.

A cursory review of the current options for measuring the reflectance, specularity, and figure of mirrors is presented. The extension of both traditional and novel optical laboratory techniques to field applications is also discussed. It is concluded that while the presently available techniques are invaluable for laboratory testing of moderately sized optical components, they offer no immediate solution to the problem of quality assessment of large solar optics. This is due to the difficulty in altering the techniques to accommodate large optics either because of physical limitation or financial constraints. In general, the spatial resolution capabilities of the available techniques are either too stringent (i.e., interferometry) or too coarse for meaningful results. However, it is felt that eventually viable techniques will evolve based directly or indirectly on concepts presented in this document.

25611 Analysis of systems for the generation of electricity from solar radiation. Pollard, W.G. (Oak Ridge Assoc Univ, Tenn). *Sol. Energy;* **23**: No. 5, 379-392(1979).

The analysis developed relates the annual electrical output of any type solar-electric facility directly to the effective annual insolation received on its solar collectors per unit collector area. A general expression for the capacity factor of such a facility is derived through which the ratio of the actual annual electrical output to the maximum mean annual output without demand, generating and downtime reductions, and storage losses can be determined. A general expression for a solar availability factor is also obtained which measures the ratio of the maximum mean annual output of the solar facility to that of a conventional fuel-fired plant of the same installed capacity generating at full capacity continuously for a year. An expression for the fraction of the total electrical output supplied by the solar facility is also derived. The analysis takes full account of the daily and electrical output supplied by the solar facility is also derived. The analysis takes full account of the daily and seasonal cycles of solar radiation and its intermittent stochastic character. All results are given for a unit area of solar collector and are thus independent of the size of the facility. 8 refs.

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 25794, 25801, 25809

25612 (DOE/ET/20567—1/1) **Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Final report. Volume I. Executive summary.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Jan 1980. Contract AC03-78ET20567. 48p. (ESG—79-30(Vol.1)). NTIS, PC A03/MF A01.

The overall, long-term objective of the Solar Central Receiver Hybrid Power System program is to identify, characterize, and ultimately demonstrate the viability and cost effectiveness of solar/fossil, steam Rankine cycle, hybrid power systems that: (1) consist of a combined solar central receiver energy source and a nonsolar energy source at a single, common site, (2) may operate in the base, intermediate, and peaking capacity modes, (3) produce the rated output independent of variations in solar insolation, (4) provide a significant savings (50% or more) in fuel consumption, and (5) produce power at the minimum possible cost in mills/kWh. It is essential that these hybrid concepts be technically feasible and economically competitive with other systems in the near to mid-term time period (1985-1990) on a commercial scale. The program objective for Phase I is to identify and conceptually characterize solar/fossil steam Rankine cycle, commercial-scale, power plant systems that are economically viable and technically feasible. A summary of results of Phase I is given in this volume. (WHK)

25613 (DOE/ET/20567—1/2(Bk.1)) **Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Final report. Volume II, Book 1. Conceptual design, Sections 1 through 4.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Jan 1980. Contract AC03-78ET20567. 277p. (ESG—79-30(Vol.2)(Bk.1)). NTIS, PC A13/MF A01.

The overall, long-term objective of the Solar Central Receiver Hybrid Power System program is to identify, characterize, and ultimately demonstrate the viability and cost effectiveness of solar/fossil, steam Rankine cycle, hybrid power systems that: (1) consist of a combined solar central receiver energy source and a nonsolar energy source at a single, common site, (2) may operate in the base, intermediate, and peaking capacity modes, (3) produce the rated output independent of variations in solar insolation, (4) provide a significant savings (50% or more) in fuel consumption, and (5) produce power at the minimum possible cost in mills/kWh. It is essential that these hybrid concepts be technically feasible and economically competitive with other systems in the near to mid-term time period (1985-1990) on a commercial scale. The program objective for Phase I is to identify and conceptually characterize solar/fossil steam Rankine cycle, commercial-scale, power plant systems that are economically viable and technically feasible. This volume presents in detail the market analysis, parametric analysis, and the selection process for the preferred system. (WHK)

25614 (DOE/ET/20567—1/2(Bk.2)) **Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Final report. Volume II, Book 2. Conceptual design, Sections 5 and 6.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Jan 1980. Contract AC03-78ET20567. 317p. (ESG—79-30(Vol.2)(Bk.2)). NTIS, PC A14/MF A01.

The overall, long-term objective of the Solar Central Receiver Hybrid Power System program is to identify, characterize, and ultimately demonstrate the viability and cost effectiveness of solar/fossil, steam Rankine cycle, hybrid power systems that: (1) consist of a combined solar central receiver energy source and a nonsolar energy source at a single, common site, (2) may operate in the base, intermediate, and peaking capacity modes, (3) produce the rated output independent of variations in solar insolation, (4) provide a significant savings (50% or more) in fuel consumption, and (5) produce power at the minimum possible cost in mills/kWh. It is essential that these hybrid concepts be technically feasible and economically competitive with other systems in the near to mid-term time period (1985-1990) on a commercial scale. The program objective for Phase I is to identify and conceptually characterize solar/fossil steam Rankine cycle, commercial-scale, power plant systems that are economically viable and technically feasible. This volume contains the detailed conceptual design and cost/performance estimates and an assessment of the commercial scale solar central receiver hybrid power system. (WHK)

25615 (DOE/ET/20567—1/3) **Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Final report. Volume III. Appendices.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Jan 1980. Contract AC03-78ET20567. 652p. (ESG—79-30(Vol.3)). NTIS, PC A99/MF A01.

The overall, long term objective of the Solar Central Receiver Hybrid Power System is to identify, characterize, and ultimately demonstrate the viability and cost effectiveness of solar/fossil, steam Rankine cycle, hybrid power systems that: (1) consist of a combined solar central receiver energy source and a nonsolar energy source at a single, common site, (2) may operate in the base, intermediate, and peaking capacity modes, (3) produce the rated output independent of variations in solar insolation, (4) provide a significant savings (50% or more) in fuel consumpton, and (5) produce power at the minimum possible cost in mills/kWh. It is essential that these hybrid concepts be technically feasible and economically competitive with other systems in the near to mid-term time period (1985-1990) on a commercial scale. The program objective for Phase I is to identify and conceptually characterize solar/fossil steam Rankine cycle, commercial-scale, power plant systems that are economically viable and technically feasible. This volume contains appendices to the conceptual design and systems analysis studies gien in Volume II, Books 1 and 2. (WHK)

25616 (SAND—80-8214) **Solar industrial process heat markets for central receiver technology.** Fish, J.D. (Sandia National Labs., Livermore, CA (USA)). Apr 1980. Contract EY-76-C-04-0789. 19p. NTIS, PC A02/MF A01.

Although the emphasis of the Solar Central Reeiver Program over the past few years has been electrical generation for utilities, there is renewed interest in the role for central receiver technology within the industrial sector for process heat applications. Process heat accounts, for approximately one half of industrial energy usage and for approximately one sixth of the total US energy usage. Based

on a synthesis of th available information concerning industrial process heat markets, it is concluded that only two types of central receiver systems need be developed to have significant impact on industry. (1) systems producing saturated steam up to 550°F, and 2) systems systems delivering air up to 2000-1500°F. Applications amenable to near-term penetration are identified for both types of systems. Finally, a number of program elements to define the specific characteristics of the tow systems are presented.

25617 (SERI/TR—8052-2) **Heliostat production evaluation and cost analysis.** (General Motors Corp., Warren, MI (USA). GM Transportation Systems Div.). Dec 1979. Contract EG-77-C-01-4042. 27p. NTIS, PC A03/MF A01.

The primary objective of ths study is to provide a factory cost for the production of heliostats in terms of 1979 dollars. Factory cost is defined as the sum of all direct labor, direct material and burden expenses that are incurred in the manufacture of a heliostat, and its packaging for shipment. Transportation, installation, taxes other than plant real taxes, profit, selling expenses, and all other profit and loss items are not included. Two production volumes are considered, 25,000 heliostat units per year and 250,000 heliostat units per year. The study concluded that the factory cost to manufacture heliostats is $95.99/m² at 25,000 units per year and $67.95/m² at 250,000 units per year. The Policy Analysis Branch of the Solar Energy Research Institute estimates that this implies an installed price of $122.12/m² at the 25,000 unit per year volume.

DISTRIBUTED COLLECTOR

REFER ALSO TO CITATION(S) 25771, 25772, 25774, 25782, 25785, 25798, 25808, 26244

25618 (ALO—4159-1) **Design, construction, and operation of a 150 kW solar-powered irrigation facility. Phase II. Final report, September 30, 1977-September 30, 1979.** Duffy, D.; Matteo, M.; Rafinejad, D. (Acurex Corp., Mountain View, CA (USA). Alternate Energy Div.). May 1980. Contract EG-77-C-04-4159. 147p. NTIS, PC A07/MF A01.

Acurex Corporation was contracted to design, construct and startup a solar powered experimental facility to provide 150 kW of electric power for the operation of deep-well irrigation pumps. Acurex also supplied its Model 3001 Solar Collector. This facility is located on the Dalton Cole Farm near Coolidge, Arizona. The facility is presently the largest operating solar thermal powerplant in the world. Experience gained on this plant will pave the way for many future power generation facilities. The present International Energy Agency (IEA) project in Spain is utilizing technology learned on the 150 kW project. The project was operated and completed by September 30, 1979 and was turned over to the DOE technical advisor, Sandia Laboratories, and the University of Arizona on October 1, 1979. The dedication of the project occurred on November 9, 1979. The solar collectors were tracking on full automatic, and the power conversion system started up and operated on automatic control for full demonstration to the public and many honored guests.

25619 (DOE/JPL—1060-30(Vol.2)) **Annual technical report. Fiscal Year 1979. Volume II. Detailed report.** (Jet Propulsion Lab., Pasadena, CA (USA); National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1 Apr 1980. Contract EX-77-A-29-1060. 134p. NTIS, PC A07/MF A01.

This report details accomplishments of the Point-Focusing Distributed Receiver Technology Project during Fiscal Year 1979. The objective of this Project is to produce thermal and electrical power from the sun's radiated energy by means of Point-Focusing Distributed Receiver (PFDR) technology. A specific goal of this effort is to develop industrial capability and system designs which will enable power produced by PFDR technology to be economically competitive with other energy sources. Present studies involve designs of modular units that collect and concentrate solar energy via highly reflective, parabolic-shaped dishes. The concentrated energy is then converted to heat in a working fluid, such as hot gas. In modules designed to produce heat for industrial applications, a flexible line conveys the heated fluid from the module to a heat transfer network. In modules designed to produce electricity, the fluid carries the heat directly to an engine in a power conversion unit located at the focus of the concentrator. The engine is mechanically linked to an electric generator. A Brayton-cycle engine is currently being developed as the most promising electrical energy converter to meet near-future needs.

25620 (DOE/JPL—1060-33) **Proceedings of the first semi-annual Distributed Receiver Systems Program Review.** (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Apr 1980. Contract EX-77-A-29-1060. 269p. NTIS, PC A12/MF A01.

Separate abstracts were prepared for the 37 papers presented. (WHK)

25621 (DOE/JPL—1060-33, pp 75-85) **Development of an air Brayton and a steam Rankine solar receiver.** Greeven, M. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Both an air Brayton and a steam Rankine solar receiver now under development for the Department of Energy under contract to the Jet Propulsion Laboratory are described. These cavity receivers accept concentrated insolation from a single-point focus, parabolic concentrator, and use this energy to heat the working fluid. Both receivers have been designed for a solar input of 85 kW. The air Brayton receiver heats the air to (16°C (1500°F). A metallic plate-fin heat transfer surface is used in this unit to effect the energy transfer. The steam Rankine receiver has been designed as a once-through boiler with reheat. The receiver heats the water to 704°C (1300°F) to produce steam at 17.22 MPa (2500 psi) in the boiler section. The reheat section operates at 1.2 MPa (75 psi), reheating the steam to 704°C (1300°F). The paper discusses the thermal and mechanical design features of the Brayton receiver and reviews the design of the Rankine receiver.

25622 (DOE/JPL—1060-33, pp 87-93) **Organic Rankine receiver for the SCSTPE program.** Osborn, D.B. (Ford Aerospace and Communications Corp., Newport Beach, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A brief description of an Organic Rankine Cycle (ORC) Receiver which is presently being developed for the SCSTPE Phase II program is presented. The receiver employs an integrated cavity/pool boiler which permits the design of a small, lightweight, low cost and efficient moderate temperature receiver for use in a dish-Rankine PFDR system.

25623 (DOE/JPL—1060-33, pp 99-105) **SCSTPE organic Rankine engine.** Boda, F. (Ford Aerospace and Communications Corp., Newport Beach, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The Organic Rankine cycle (ORC) engine under consideration for the PFDR solar thermal system being developed for JPL/DOE by FACC is described. Design parameters, method of control, performance and cost data are provided for engine power levels up to 80 kWe; efficiency is shown as a function of turbine inlet temperature in the range of 149°C (300°F) to 427°C (800°F).

25624 (DOE/JPL—1060-33, pp 107-112) **Hybrid Brayton engine concept.** Six, L.; Elkins, R. (AiResearch Manufacturing Co. of Arizona, Phoenix). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A first generation open cycle Brayton engine concept for use in full-scale solar module testing, was defined in NASA/JPL study contract DEN 3-69. This concept has been extended to include solar/fossil hybrid capability. The combustion system defined for hybrid operation consists of a wide range combustor liner, a single airblast atomizer, an ignitor and a high-voltage ignition unit. Wide range combustor operation would be achieved through combining pilot and primary zones. The hybrid control mode and the solar only control mode are both based on the concept of maintaining constant turbine inlet temperature and varying the engine speed for part-power operation. In addition, the hybrid control concept will allow the operator to set a minimum thermal power input to the engine by setting a corresponding minimum engine speed. When the solar thermal power input falls below this minimum, fossil fuel would be utilized to augment the solar thermal power input.

25625 (DOE/JPL—1060-33, pp 159-167) **Dish-Rankine SCSTPE program (engineering experiment No. 1).** Pons, R.L.; Grigsby, C.E. (Ford Aerospace and Communications Corp., Newport Beach, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The activities planned for Phase II of the Small Community Solar Thermal Power Experiment (SCSTPE) program are summarized. A Dish-Rankine Point Focusing Distributed Receiver (PFDR) solar thermal electric system will be designed and developed and a single power module tested at the JPL Solar Thermal Test Facility, Edwards AFB, California. Major design efforts will include: development of an advanced concept indirect-heated receiver; development of hardware and software for a totally unmanned power plant control system; implementation of a hybrid digital simulator which will validate plant operation prior to field testing; and the acquisition of an efficient organic Rankine cycle (ORC) power conversion unit (PCU). Preliminary performance analyses indicate that a mass-produced Dish-Rankine PFDR system is potentially capable of producing electricity at a levelized busbar energy cost of 60 to 70 mills per KWh and with a capital cost of about $1300 per KW.

25626 (DOE/JPL—1060-33, pp 169-173) **Siting solar thermal power experiments.** Holbeck, H.J. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Solar thermal power experiments will provide experimental operation data bases leading to later full-scale demonstrations. The Small Community Solar Thermal Power Experiment will test a point-focusing distributed receiver system in a small community, electric utility application. Site participation and system development for this experiment are being pursued in separate, coordinated efforts. Site planning is becoming increasingly important for solar experiments as well as all kinds of development due to increased competition for desirable sites and increased complexity of regulatory requirements. Siting issues can be categorized as: (1) resources and physical environment at this site; (2) acquisition, permits and regulations; (3) development requirements and costs. In this paper these issues are addressed with respect to the unique requirements of solar thermal power experiments.

25627 (DOE/JPL—1060-33, pp 175-179) **JPL isolated application experiment series.** Levin, R.R. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The goal of the Thermal Power System Project's Applications Development element is to establish the technical, operational, and economic readiness of small power systems for a variety of applications in the power range below 10 MWe. Power Systems are being developed and tested to the point where commercialization efforts can lead to successful market penetration. A key element in this strategy is the use of experiments to test hardware and assess operational readiness. The JPL Isolated Application Experiments are described and their objectives discussed.

25628 (DOE/JPL—1060-33, pp 221-227) **IEA/SPS 500 kW distributed collector system.** Neumann, T.W.; Hartman, C.D. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The results of engineering studies for an International Energy Agency (IEA) project for the design and construction of a 500 kWe (net) solar thermal-electric power generation system of the Distributed Collector System (DCS) type are reviewed. The project is part of the IEA Small Solar Power System (SSPS) Project, and is being constructed as a demonstration plant in the province of Almeria in Southern Spain. The DCS system design was completed by a 10 nation team headed by Acurex Corporation, a US firm. Construction is presently underway. The design consists of a mixed field of parabolic trough-type solar collectors of both German and US design which are used to heat a thermal heat transfer oil. Heated oil is delivered to a thermocline storage tank from which heat is extracted and delivered to a boiler by a second heat transfer loop using the same heat transfer oil. Steam is generated in the boiler, expanded through a steam turbine, and recirculated through a condenser system cooled by a wet cooling tower.

25629 (DOE/JPL—1060-33, pp 229-233) **Coolidge solar powered irrigation pumping project.** Larson, D.L. (Univ. of Arizona, Tucson). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Construction of a 150 kW solar thermal-electric power plant on an irrigated farm near Coolidge was completed in autumn, 1979. The plant, designed by Acurex Corp., includes over 2100 m^2 of Acurex made parabolic trough type collectors and an organic Rankine cycle turbine engine built by Sundst.and Corp. The plant is interconnected with the electrical utility grid. The installation is being operated by the University of Arizona with Sandia Laboratories direction. Operation is providing an evaluation of equipment performance and operating and maintenance requirements as well as the desirability of an on-farm location.

25630 (FWDC—9-41-341106) **Conceptual design of a heat pipe solar receiver gas turbine plant. Final report.** Carli, G. (Foster Wheeler Corp., Livingston, NJ (USA)). 15 Sep 1978. Contract EY-76-C-02-2839. 102p. NTIS, PC A06/MF A01.

A conceptual design for a 10-MWe Heat Pipe Central Receiver Gas-Turbine Power Plant has been developed. The heat pipe central solar receiver uses heat pipes to transform the concentrated high solar heat flux at the receiver into a lower heat flux compatible with gas heat-transfer systems. Several Brayton cycles were studied to determine which cycles and operating conditions are technically and economically most viable for a central receiver power plant. A regenerative open-gas cycle with an inlet turbine temperature of 816°C (1500°F) was selected. The turbine-generator and receiver are located at the top of a steel tower, with a north field of 2-axis tracking heliostats. The system can be adapted for operation as a hybrid plant, providing a higher level of availability and a dependable generating capacity - important considertions from the utility point of view. The predicted cycle efficiency is 33 to 38 percent, and the overall solar-to-electric efficiency is 19.1 to 22.3 percent. Capital cost of the plant is estimated to be in the $1947 to $2002/kW range, depending on the assumed cost for the collector system. Compared with a water/steam solar system, estimated costs in mid-1978 dollars are lower and plant efficiency is superior.

25631 (SAN—20500-1(Vol.2)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract EM-78-C-03-1725. 203p. NTIS, PC A10/MF A01.

The conceptual design analysis for the 100-MWe liquid-metal central receiver commercial power plant is presented. Subsystem design and analysis procedures and results are presented for the heliostat field, central receiver, sodium sensible heat storage system, electric power generation system, control systems, and balance of plant. Drawings are included. (WHK)

25632 (SAN—20500-1(Vol.3)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract EM-78-C-03-1725. 123p. NTIS, PC A06/MF A01.

An assessment of the 100-MWe liquid-metal commercial tower focus power plant concept is presented. An economic assessment is given and a plant capital cost estimate is made for the site, structures, and miscellaneous equipment; turbine plant equipment; electric plant equipment; collector equipment; receiver equipment; thermal storage equipment; distributables and indirect costs; and operating and maintenance costs. Also included is an environmental analysis and a safety analysis. (WHK)

25633 (SAN—20500-1(Vol.4)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract ET-78-C-03-1725. 165p. NTIS, PC A08/MF A01.

A development plan designed to meet the objectives of bringing the advanced sodium-cooled central receiver design to the final stage of development and generating sufficient technical and economic data to effect commercial and utility acceptance of the concept has been identified. This development plan builds upon the first phase of the overall program, which is the subject of this report, and is designed to be implemented in three subsequent phases. Phase I of the program established the basic plant configuration, conceptual design, performance and cost estimates, and a pilot plant concept which is scaled to provide the subsystem integration and operational information required to establish confidence in the commercial plant design. Phase II will incorporate improvements into the commercial plant conceptual design and will provide, through subsystem research experiments, the detailed design information required to proceed with the commercial plant preliminary design in a cost-effective manner. It will provide a pilot plant preliminary design which can serve as the basis for the detailed design of the pilot plant during Phase III. Phase III involves selection of the pilot plant site, completion of the detailed design of the pilot plant, and construction. Following construction, the plant will be operated to provide data to support and guide the commercial plant design. Toward the end of this phase, a preliminary design of the commercial plant will be completed. The detailed design of the commercial plant will be completed in Phase IV. The site will be selected, and an environmental impact statement will be prepared. This will advance the status of the program to the point where plant construction could begin.

25634 (SAN—20500-1(Vol.5)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract EM-78-C-03-1725. 259p. NTIS, PC A12/MF A01.

The conceptual design of a 100-MWe liquid-metal commercial tower focus power plant is described. This volume contains the appendices: (A) efficiency and cost estimates for cavity receivers, parametric analysis; (B) absorber loss calculations for parametric analysis; (C) small electromagnetic pumps for parametric analysis; (D) tower cost estimates for parametric analysis; (E) Riser/downcomer cost estimates for parametric analysis; (F) transient thermal analysis of sodium/iron storage; (G) details of field fabricated storage vessel cost estimates for parametric analysis; (H) steam generator heat balances for parametric analysis; (I) heat exchanger cost estimates for parametric analysis; (J) comparison of molten salt and sodium as secondary loop fluids; (K) parametric analysis of steam cycles; (L) materials evaluation and selection; (M) hydraulic analysis of absorber concept; (N) technique for estimating air side convection coefficient on absorber; (O) absorber loss computer program; (P)

steam generator conceptual design analysis - computer program output; (Q) critique of cylindrical storage tanks; and (R) sodium component design - supplemental calculations. (WHK)

25635 (ATR—80(7773-03)-1(Vol.2)) **Evaluation of line focus solar central power systems. Volume II. Systems evaluation.** (Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.). 15 Mar 1980. Contract EY-76-C-03-1101-014. 213p. NTIS, PC A10/MF A01.

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. It was concluded that although the high temperature line focus (SRI) and fixed mirror line focus (GA) concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts these configurations do not offer a sufficient improvement in cost to warrant full scale development. The systems are, however, less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives. The parabolic trough concept (BDM) was found to provide a low temperature technology alternative to the central receiver concept with promising performance and cost potential. Its continued development is recommended, with special emphasis on lower temperature (< 700°F) applications. Finally, a variety of new promising line focus power system configurations were identified for a range of utility and industrial applications and recommendations were made on their implementation. This volume contains the detailed report. (WHK)

25636 (ATR—80(7773-03)-1(Vol.1)) **Evaluation of line focus solar central power systems. Volume I. Executive summary.** (Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.). 15 Mar 1980. Contract EY-76-C-03-1101-014. 28p. NTIS, PC A03/MF A01.

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. It was concluded that although the high temperature line focus (SRI) and fixed mirror line focus (GA) concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts these configurations do not offer a sufficient improvement in cost to warrant full scale development. The systems are, however, less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives. This volume is an executive summary. (WHK)

25637 (SAN—20500-1(Vol.1)(Pt.1)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract EM-78-C-03-1725. 23p. NTIS, PC A02/MF A01.

Results are summarized of the conceptual design, cost and performance estimate, and development plan for a 100 MW tower focus liquid-metal commercial solar power plant. (WHK)

25638 (SAN—20500-1(Vol.1)(Pt.2)) **Conceptual design of advanced central receiver power systems. Final technical report.** Brower, A.S.; Doyle, J.F.; Gerrels, E.E.; Ku, A.C.; Pomeroy, B.D.; Roberts, J.M.; Salemme, R.M. (General Electric Co., Schenectady, NY (USA)). 29 Jun 1979. Contract EM-78-C-03-1725. 208p. NTIS, PC A10/MF A01.

A parametric analysis to identify the preferred plant components and configuration for a 100 MWe solar central receiver commercial power plant is described in detail. Components studied include heliostats, central receiver, storage system, electric power generation subsystem, and master control system. The advanced central receiver plant concept selected as a result of the parametric analysis is described. It consists of a 360° field of enclosed plastic heliostats focusing onto a cylindrical receiver operating at a peak sodium temperature of 1100 F. The heliostats are focused to slant range to achieve higher fluxes and lower receiver losses. Pressure reduction at the base of the downcomer is accomplished using a throttle valve complex. Hot and cold sodium is stored in separate arrays of field assembled tanks, and sodium is supplied to the steam generators by a pumping loop which is isolated from the absorber loop by the tanks. Separate steam generator modules provide the evaporation, superheat, and reheat functions required to deliver steam to a high efficiency steam cycle (2400 psi/1000 F/1000 F with heaters above the reheat point). (WHK)

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 25778

25639 (DOE/JPL—1060-33, pp 181-184) **Industrial application experiment series.** Bluhm, S.A. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The objectives and implementation plan for the Industrial Application Experiment Series of the Applications Development element of the Thermal Power Systems Project are presented. The first experiment in the series will be the Industrial Thermal Module Experiment. The approach to implementing the experiment is presented and an implementation schedule is provided.

25640 (DOE/JPL—1060-33, pp 247-249) **Solar total energy-large scale experiment.** Hensley, W.R. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Now being completed is the Phase IV Definitive Design of a six-phase Project for conducting a Solar Total Energy Large Scale Experiment in late 1981. General Electric Company is designing the Solar Total Energy System (STES) with capacity to supply 60% of the total electric and thermal requirements of the 42,000 square foot Bleyle of Americca knitwear plant to be served at the Shenandoah Site. The system will provide 400 kilowatts electrical and 3.5 megawatts thermal energy. The STES has a classical, cascaded total energy system configuration. It utilizes parabolic dish collectors, trickle oil thermal energy storage and a steam turbine-generator. The electrical load peak shaving system is being designed for interconnected operation with the Georgia Power system.

25641 (DOE/JPL—1060-33, pp 251-255) **Solar Total Energy Project at Shenandoah, Georgia System Design.** Poche, A.J. (General Electric Co., King of Prussia, PA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The US Department of Energy, with Sandia Laboratories providing technical support and management, is near completion of the Definitive Design Phase of the Solar Total Energy Project to be constructed at Shenandoah, Georgia. General Electric Company designed the Solar Total Energy System (STES) with the capacity to provide 50% of the total electrical and thermal energy requirements of the 25,000-square-foot Bleyle of America knitwear plant located at the Shenandoah Site. The system will provide 400 kilowatts electrical and 3 megawatts of thermal energy. The STES has a classical, cascaded total energy system configuration. It utilizes one hundred twenty (120), parabolic dish collectors, high temperature (750°F) trickle oil thermal energy storage and a steam turbine-generator. The electrical load peak shaving system has been designed for interconnected operation with the Georgia Power system and for operation in a stand alone mode.

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 25469, 25470

25642 (ANL/OTEC-BCM—008) **Stress-corrosion cracking of steels in ammonia with consideration given to OTEC design: a survey.** Teel, R.B. (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 44p. NTIS, PC A03/MF A01.

Carbon steel, alloy steel, and high-strength, quenched and tempered steel, when under applied or residual stress and especially when cold formed and/or welded without subsequent thermal stress relief, are subject to failure by stress-corrosion cracking (SCC) in air-contaminated dry ammonia. Water as well as hydrazine when present in small amounts have been shown to be effective inhibitors in an all steel system. Galvanic corrosion between dissimilar metals and/or accelerated failure by SCC of stressed steel as a result of galvanic coupling may be of concern. Where water has proven effective as an inhibitor of SCC in an all steel system, it may not be adequate in a mixed metal system. With aluminum tubes, the tube sheet will either have to be solid aluminum, aluminum clad steel or some nonconductive coating will be necessary to effectively remove the cathodic alloy from the galvanic circuit. Research is required to determine the severity of the coupling effect between dissimilar alloys in ammonia under OTEC conditions; especially the possibility of accelerated SCC failures of stressed steel where the presence of an inhibitor in the ammonia may not be sufficient to override the galvanic coupling effect.

25643 (COO—4238-14) **Continued evaluation of compact heat exchangers for OTEC evaluation. Final report.** McGowan, J.G. (Massachusetts Univ., Amherst (USA)). Oct 1979. Contract EG-77-S-02-4238. 141p. Dep. NTIS, PC A07/MF A01.

The objectives of this work investigating the applicability of compact plate heat type heat exchangers to OTEC power systems were: (1) an analytical and experimental evaluation of the performance characteristics of compact heat exchangers using ammonia as the working fluid operating under the entire range of OTEC system conditions; and (2) an evaluation of the applicable manufacturing

processes, maintenance requirements, and arrangement concepts for large-scale compact OTEC heat exchangers with specific emphasis on total economics. The work was carried out to establish the applicability of compact plate type heat exchangers to OTEC power systems and to provide: (1) experimental verification of predicted performance (heat transfer and fluid flow) under OTEC operating conditions (using NH_3); (2) provide initial performance data for several desirable plate type OTEC heat exchanger panels; (3) provide test apparatus for continued experimental testing of OTEC compact heat exchanger panels; and (4) provide design information on applicable manufacturing processes maintenance requirements and arrangement concepts for plate type heat exchangers.

25644 (DOE/CS—0161) **Ocean energy systems. Multiyear Program Plan.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy). May 1980. 130p. NTIS, PC A07/MF A01.

Spcific planned activities to be conducted by the Department of Energy in connection with the Ocean Energy System Program for FY 1979 through FY 1984 are described. Program funding is presently 95 percent OTEC, with 5 percent directed toward alternate energy sources such as salinity gradients, waves, and currents. Program strategy, ocean energy systems resource requirements, technical status, OTEC commercialization strategies, environmental issues, and a management plan are discussed. (WHK)

25645 (DOE/ET/20483—2) **Research on the external fluid mechanics of ocean thermal energy conversion plants: report covering experiments in stagnant water.** Adams, E.E.; Fry, D.J.; Coxe, D.H.; Harleman, D.R.F. (Massachusetts Inst. of Tech., Cambridge (USA). Ralph M. Parsons Lab. for Water Resources and Hydrodynamics). Jun 1979. Contract ET-78-S-02-4683. 104p. NTIS, PC A06/MF A01.

This report describes the first set of experiments in a physical model study to explore plume transport and recirculation potential for a range of generic Ocean Thermal Energy Conversion (OTEC) plant designs and ambient conditions. Tests were conducted in a thermally-stratified 12 m x 18 m x 0.6 m basin, at an undistorted length scale ratio of 1:300, which allowed the upper 180 m of the ocean to be studied. Measurements included temperature, dye concentration and visual observations from still photographs. Conditions which have been tested include a range of plant sizes (nominally 200 MWe - 600 MWe), a range of discharge configurations (mixed vs. non-mixed evaporator and condenser flows; multiple vs. radial slot discharge port(s); variation of discharge-intake separation and variation of discharge angle), and a range of ambient density profiles (characterized by the depth of the surface mixed layer). The tests described are for a stagnant ambient ocean. Results have shown no significant recirculation for plant sizes up to 400 MWe for discharges directed either horizontally or with a downward component. However, significant recirculation was observed in a test of a 400 MWe plant in which the discharge was directed with a slight upward component and in a test of 600 MWe plant with a horizontal discharge. No significant difference in recirculation could be discerned between the mixed and the non-mixed discharge designs. Measurements of minimum plume dilution taken at approximately 1 km (prototype) from the plant generally fell in the range of 5 to 10 with a mean value of 7.4. This indicates that peak concentrations of any chemicals contained in the discharge would be about 14% of the discharge concentration. Other information, such as the plume shape and equilibrium position, intake temperature changes and perturbations to the ambient ocean profile, are included for each run.

25646 (DOE/NOAA/OTEC—25) **At-sea test validation data needed to verify the NOAA/DOE CWP Analytic Code.** Major, R.A. (ORI, Inc., Silver Spring, MD (USA)). 12 Mar 1980. Contract EG-77-A-29-1078. 38p. (ORI-TM—110-80). NTIS, PC A03/MF A01.

Test data requirements are developed in this memorandum for the one-third scale Ocean Thermal Energy Conversion (OTEC) cold water pipe (CWP) at-sea tests. A major goal of the at-sea tests is to collect sufficient data so that the National Oceanic and Atmospheric Administration (NOAA)/Department of Energy (DOE) CWP Analytic Code can be validated. The code is examined to determine the individual responses requiring verification. The wave environment is then considered for prototype survival and the scaled test. The expected response of the OTEC CWP test article in the test environment is used to form a basis of the test plan. Requirements for the tests of standard configurations of the OTEC CWP test system are first planned followed by requirements for tests of alternate configurations and evolutions. The final product is a set of justified NOAA/CWP analytic code validation requirements.

25647 (DOE/NOAA/OTEC—26) **Assessment of US shipbuilding current capability to build a commercial OTEC platform and a cold water pipe.** Komelasky, M.C. (ed.). (ORI, Inc., Silver Spring, MD (USA)). Mar 1980. Contract EG-77-A-29-1078. 107p. NTIS, PC A06/MF A01.

Lowry and Hoffman Associates Inc. (LHA) performed for ORI an analysis of the shipbuilding requirements for constructing an OTEC plant, and the available shipyard assets which could fulfill these requirements. In addition, several shipyards were queried concerning their attitudes towards OTEC. In assessing the shipbuilding requirements for an OTEC plant, four different platform configurations were studied and four different designs of the cold water pipe (CWP) were examined. The platforms were: a concrete ship design proposed by Lockheed; concrete spar designs with internal heat exchangers (IHE) (Rosenblatt) and external heat exchangers (XHE) (Lockheed); and a steel ship design proposed by Gibbs and Cox. The types of materials examined for CWP construction were: steel, fiber reinforced plastic (FPR), elastomer, and concrete. The report is organized io three major discussion areas. All the construction requirements are synthesized for the four platforms and CWPs, and general comments are made concerning their availability in the US. Specific shipbuilders facilities are reviewed for their applicability to building an OTEC plant, an assessment of the shipyards general interest in the OTEC program is presented providing an insight into their nearterm commercial outlook. The method of determining this interest will depend largely on a risk analysis of the OTEC system. Also included are factors which may comprise this analysis, and a methodology to ascertain the risk. In the appendices, various shipyard specifications are presented, shipyard assessment matrices are given, graphs of various shipyard economic outlooks are provided, and definitions of the risk factors are listed. (WHK)

25648 (DOE/NOAA/OTEC—27) **OTEC elastomer cold water pipe preliminary design study. Final report.** Mehring, R.D. (Goodyear Aerospace Corp., Akron, OH (USA)). 13 Nov 1979. Contract EG-77-A-29-1078. 77p. (GAC—19-1284). NTIS, PC A05/MF A01.

Goodyear Aerospace Corporation has analyzed the requirements for a 30 ft dia 3280 ft long Cold Water Pipe for an Ocean Thermal Energy Conversion (OTEC) 10/40 MW Pilot Plant. A preliminary design using elastomer covered, flexible steel cable, conveyor belt material is presented. The design concept was predicated on employing state-of-the-art production techniques and having the capability for expansion to a commercial power plant size without further development. The report provides a data base for a compliant elastomer pipe and includes material properties, design details, cost, fabrication and schedule information. Both cable and fabric reinforced constructions are addressed and a comparison of various concepts for assembly of the pipe sections has been made.

25649 (DOE/NOAA/OTEC—28) **OTEC cold water pipe design for problems caused by vortex-excited oscillations.** Griffin, O.M. (Naval Research Lab., Washington, DC (USA)). 14 Mar 1980. Contract EG-77-A-29-1078. 148p. (NRL-MR—4157). NTIS, PC A07/MF A01.

Vortex-excited oscillations of marine structures result in reduced fatigue life, large hydrodynamic forces and induced stresses, and sometimes lead to structural damage and to diestructive failures. The cold water pipe of an OTEC plant is nominally a bluff, flexible cylinder with a large aspect ratio (L/D = length/diameter), and is likely to be susceptible to resonant vortex-excited oscillations. The objective of this report is to survey recent results pertaining to the vortex-excited oscillations of structures in general and to consider the application of these findings to the design of the OTEC cold water pipe. Practical design calculations are given as examples throughout the various sections of the report. This report is limited in scope to the problems of vortex shedding from bluff, flexible structures in steady currents and the resulting vortex-excited oscillations. The effects of flow non-uniformities, surface roughness of the cylinder, and inclination to the incident flow are considered in addition to the case of a smooth cyliner in a uniform stream. Emphasis is placed upon design procedures, hydrodynamic coefficients applicable in practice, and the specification of structural response parameters relevant to the OTEC cold water pipe. There are important problems associated with in shedding of vortices from cylinders in waves and from the combined action of waves and currents, but these complex fluid/structure interactions are not considered in this report.

25650 (DOE/NOAA/OTEC—29) **Preliminary design for Ocean Thermal Energy Conversion (OTEC) Stationkeeping Subsystem (SKSS). Task IV. Development and testing recommendations.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA (USA)). 9 Nov 1979. Contract EG-77-A-29-1078. 39p. (LMSC-D—677783). NTIS, PC A03/MF A01.

The preliminary designs of Stationkeeping Subsystems (SKSS) for the OTEC Modular Experiment Plant are being prepared for a barge and spar platform. The SKSS selected by NOAA for the barge is a multiple anchor leg mooring with active tensioning (MAL), while that for the spar is a tension anchor leg (TAL) moor. The development and testing program required to provide design data and to validate performance predictions is described. Basic assumptions are made with regard to site characteristics, behavior of the SKSS and platform in the sea state, and characteristics of SKSS components. The test program is intended to provide the data necessary to confirm assumptions or to support design revisions. The testing program for the multiple anchor leg system is considered first, followed by the tension anchor leg program. Development and

testing are recommended in the areas of materials, components and procedures which are beyond modest extrapolation of current ocean engineering practice. (WHK)

25651 (DOE/NOAA/OTEC—30(Vol.1)) **Modular OTEC platforms, SKSS designs. Volume I. Executive summary. Final report.** (Rosenblatt (M.) and Son, Inc., New York (USA)). 29 Feb 1980. Contract EG-77-A-29-1078. 82p. NTIS, PC A05/MF A01.

One of the possible options for generating electrical energy from ocean thermal gradients requires the use of a floating offshore platform. The platform would contain all OTEC (Ocean Thermal Energy Conversion) systems and power cycle components and consist of the hull, seawater, station-keeping, platform service, and mission support subsystems. It would be stationed at one of the designated OTEC sites, and would transmit the generated electricity to the shore power networks by means of an electrical transmission cable. The objective of the present study is to investigate the station-keeping subsystem (SKSS) requirements and develop preliminary SKSS designs for the two Modular Experiment Plant (MEP) candidates of 10/40 MW/sub e/ capacity for deployment at a specific site. The two MEP hull candidates are a Barge type platform and a Spar shaped hull with external heat exchangers. The specific site assigned for this study is Puerto Rico. The preliminary SKSS designs are developed for both platforms as follows: (1) an 8-leg spread catenary mooring system for the Spar, and (2) a 12-leg spread catenary mooring system for the Barge. Applicability of these designs to larger capacity commercial OTEC platforms is also investigated.

25652 (DOE/NOAA/OTEC—30(Vol.2)) **Conceptual designs for modular OTEC SKSS. Final report.** (Rosenblatt (M.) and Son, Inc., New York (USA)). 29 Feb 1980. Contract EG-77-A-29-1078. 310p. NTIS, PC A14/MF A01.

This volume presents the results of the first phase of the Station Keeping Subsystem (SKSS) design study for 40 MW/sub e/ capacity Modular Experiment OTEC Platforms. The objectives of the study were: (1) establishment of basic design requirements; (2) verification of technical feasibility of SKSS designs; (3) identification of merits and demerits; (4) estimates of sizes for major components; (5) estimates of life cycle costs; (6) deployment scenarios and time/cost/risk assessments; (7) maintenance/repair and replacement scenarios; (8) identifications of interface with other OTEC subsystems; (9) recommendations for and major problems in preliminary design; and (10) applicability of concepts to commercial plant SKSS designs. A brief site suitability study was performed with the objective of determining the best possible location at the Punta Tuna (Puerto Rico) site from the standpoint of anchoring. This involved studying the vicinity of the initial location in relation to the prevailing bottom slopes and distances from shore. All subsequent studies were performed for the final selected site. The two baseline OTEC platforms were the APL BARGE and the G and C SPAR. The results of the study are presented in detail. The overall objective of developing two conceptual designs for each of the two baseline OTEC platforms has been accomplished. Specifically: (1) a methodology was developed for conceptual designs and followed to the extent possible. At this stage, a full reliability/performance/optimization analysis based on a probabilistic approach was not used due to the numerous SKSS candidates to be evaluated. A deterministic approach was used. (2) For both of the two baseline platforms, the APL BARGE and the G and C SPAR, all possible SKSS candidate concepts were considered and matrices of SKSS concepts were developed.

25653 (DOE/NOAA/OTEC—30(Vol.3)) **Preliminary designs for modular OTEC platform station-keeping subsystems. Final report. MR and S Report No. 6042-6.** (Rosenblatt (M.) and Son, Inc., New York (USA)). 29 Feb 1980. Contract EG-77-A-29-1078. 176p. NTIS, PC A09/MF A01.

This volume of the report presents the results of the third through the sixth tasks of the Station Keeping Subsystem (SKSS) design studies for 10/40 MW/sub e/ capacity OTEC Modular Experiment platforms (MEP). Tasks 3 through 6 are: (3) complete preliminary designs for one SKSS for each of the two platforms (SPAR and BARGE); (4) development and testing recommendations for the MEP SKSS; (5) cost-time analysis; and (6) commercial plant recommendations. The overall conclusions and recommendations for the modular, as well as the commercial, OTEC platform station keeping subsystems are delineated. The basic design assumptions made during the process, the technical approach followed, and the results of design iterations, reliability and performance analyses are given. A complete description of the preliminary design SKSS concept is presented. The summary cost estimates for each of the alternative SKSS concepts considered are presented and a time schedule for the recommended concept is provided. The effects of varying some of the important parameters used in SKSS design on the performance and cost of the mooring system are investigated and results presented. The tests required and other developmental recommendations in order to verify and confirm the basic design assumptions are discussed. Finally, the experience gained in the MEP preliminary designs are extended to future commercial OTEC plants' SKSS designs. (WHK)

25654 (DOE/NOAA/OTEC—30(Vol.4)) **OTEC SKSS preliminary designs. Volume IV. Appendixes. Final report.** (Rosenblatt (M.) and Son, Inc., New York (USA)). 29 Feb 1980. Contract EG-77-A-29-1078. 351p. NTIS, PC A16/MF A01.

This volume contains appendices to the Station Keeping Subsystem design study for the 40 MeW Modular Experiment OTEC platforms. Appendices presented include: detailed drag calculations; sample CALMS computer printouts for SPAR and BARGE static analyses; sample time domain computer printouts (Hydromechanics, Inc.) program; extreme value and fatigue load calculations; anchor design calculations; deployment calculations; bottom slope plots; time domain analysis report by Hydromechanics Inc.; detailed cost analysis; control systems study report by Sperry Systems Management; cost estimates for model basin tests; and hydrodynamic loading on the mooring cables. (WHK)

25655 (DOE/NOAA/OTEC—32(Vol.2)) **OTEC modular experiment: cold water pipe concept evaluation. Volume II. Technical report.** (Science Applications, Inc., El Segundo, CA (USA)). Apr 1979. Contract EG-77-A-29-1078. 393p. (SAI—063-80R-008-LA(Vol.2)). NTIS, PC A17/MF A01.

The Cold Water Pipe System Design Study was undertaken to evaluate the diverse CWP concepts, recommend the most viable alternatives for a 1984 deployment of the 10 to 40 MWe MEP, and carry out preliminary designs of three concepts. The Concept Evaluation Phase reported here involved a systems analysis of design alternatives in the broad categories of rigid walled (with hinges), compliant walled, stockade and bottom mounted buoyant. Quantitative evaluations were made of concept performance, availability, deployment schedule, technical feasibility and cost. CWP concepts were analyzed to determine if they met or could be made to meet established system requirements and could be deployed by 1984. Those which faced overwhelming technical and/or scheduling problems were rejected. Those which were unviable due to isolated, crucial technical and/or scheduling problems for which a technical development may reverse the decisions were deferred. Fabrication, construction and installation plans were developed for successful concepts, and costs were determined in a WBS format. Evaluations were performed on the basis of technical and cost risk. (WHK)

25656 (DSE—3407-T1) **Ocean thermal energy conversion power system development-II. Phase I. Final report. Preliminary design report.** (Lockheed Missiles and Space Co., Sunnyvale, CA (USA)). 31 Jul 1979. Contract ET-78-C-01-3407. 419p. (LMSC-D—637832). NTIS, PC A18/MF A01.

Detailed results of a preliminary design study of an Ocean Thermal Energy Conversion (OTEC) closed cycle 10-MW(e) net power system and 1/50 thermally scaled heat exchanger test articles using shell-less heat exchangers are presented. Also, applicable results of trade studies and related investigations accomplished during the Task 1, Conceptual Design, portion of the program are included. The material presented is intended to provide an understanding of the rationale leading to the selected configuration. The program requirements are presented, and a summary of the Phase I effort is included. The power system analysis and trade studies used to arrive at the selected configurations are discussed. The heat exchangers are discussed in sufficient detail to provide complete understanding of the related section in the forthcoming proposal. Detailed discussions of the rotating machinery and the remainder of the power system are given. Also, a cost analysis is presented. A complete description of the functions, design, and test objectives of the Heat Exchanger Test Articles is given. (WHK)

25657 (DSE—3407-T1(APP)) **Ocean thermal energy conversion power system development-II. Phase I. Final report.** (Lockheed Missiles and Space Co., Sunnyvale, CA (USA)). 31 Jul 1979. Contract ET-78-C-01-3407. 373p. (LMSC-D—637832(App)). NTIS, PC A16/MF A01.

Information pertinent to the preliminary design of a 10 MWe OTEC plant is presented in this volume. Appendices include (1) turbine-generator overspeed analysis and specification sheets; (2) data on seawater pumps; (3) clean-in-place subsystem (list of various detergent mixtures available); (4) plate heat exchanger data; (5) power system specifications; (6) cost data; (7) test plan for the 0.2-MWe Heat Exchanger Test Articles; and (8) related drawings. (WHK)

25658 (DSE—3408-T1) **Ocean Thermal Energy Conservation (OTEC) power system development (PDS) II. Preliminary design report.** (TRW Defense and Space Systems Group, Redondo Beach, CA (USA)). 10 Aug 1979. Contract ET-78-C-01-3408. 454p. NTIS, PC A19/MF A01.

This report documents the results and conclusions of the PDS II, Phase I, preliminary design of a 10 MWe OTEC power system, using enhanced plate type heat exchangers, and of representative 0.2 MWe test articles. It further provides the documentation (specifications, drawings, trade studies, etc.) resulting from the design activities. The data and discussions of the technical concepts are organized to respond to the PDS II, Phase II proposal evaluation criteria. This

volume, which specifically addresses the three evaluation categories (heat exchangers, rotating machinery, and power system configuration and performance) is an integral part of the Phase II plans (proposal) which describe the technical approach to delivering test articles to OTEC-1. In addition, there is a section which addresses power system cost and net energy analysis and another which discusses the results of stainless steel feasibility studies. Supporting documentation is contained in two appendix volumes.

25659 (DSE—3408-T1(App.1)) **Ocean thermal energy conversion (OTEC) power system development (PSD) II. Preliminary design report. Appendix I: specifications and drawings.** Pearson, R.O. (TRW Defense and Space Systems Group, Redondo Beach, CA (USA)). 10 Aug 1979. Contract ET-78-C-01-3408. 470p. NTIS, PC A20/MF A01.

This volume contains the specifications and drawings prepared in support of the preliminary design of a 10MWe OTEC power system using enhanced plate type heat exchangers. Included are: (1) the specification tree; (2) system specification; (3) 10 MWe heat exchangers; (4) nitrogen storage, conditioning and supply subsystem specification; (5) ammonia storage, conditioning and supply specification; (6) electrical power distribution and control subsystem specification; (7) equipment valves, instruments and live lists and specifications; (8) drawing tree; (9) drawing package; and (10) 0.2 MWe test articles procurement specifications. (WHK)

25660 (DSE—3408-T1(App.2)) **Ocean thermal energy conversion (OTEC) power system development (PSD) II. Preliminary design report. Appendix II: supporting data.** (TRW Defense and Space Systems Group, Redondo Beach, CA (USA)). 10 Aug 1979. Contract ET-78-C-01-3408. 879p. NTIS, PC A99/MF A01.

The trade studies, calculations, and reports which provide the rationale for design conclusions for the 10 MWe OTEC power system are presented in this volume. These appendices include: (1) system design and optimization model; (2) system off-design performance computer model; (3) seawater system dynamics; (4) system mechanical design studies; (5) electrical design studies; (6) structural design studies; (7) tube cleaner design report and proposed brush test program; (8) heat exchangers: mechanical design; (9) heat exchangers: thermal hydraulic computer model; (10) heat exchangers: manufacturing flow plan; (11) heat exchangers: installation and removal procedures; (12) heat exchangers: stainless steel conceptual design; (13) heat exchangers: cost studies; (14)heat exchangers: materials selection and corrosion; and (15) heat exchangers: quality assurance. (WHK)

25661 **Open cycle ocean thermal energy conversion system.** Wittig, J.M. (to Dept. of Energy). US Patent 4,189,647. 19 Feb 1980. Filed date 17 Aug 1978. 8p.

PAT-APPL-934,572.

An improved open cycle ocean thermal energy conversion system is described including a flash evaporator for vaporizing relatively warm ocean surface water and an axial flow, elastic fluid turbine having a vertical shaft and axis of rotation. The warm ocean water is transmitted to the evaporator through a first prestressed concrete skirtconduit structure circumferentially situated about the axis of rotation. The unflashed warm ocean water exits the evaporator through a second prestressed concrete skirt-conduit structure located circumferentially about and radially within the first skirt-conduit structure. The radially inner surface of the second skirt conduit structure constitutes a cylinder which functions as the turbine's outer casing and obviates the need for a conventional outer housing. The turbine includes a radially enlarged disc element attached to the shaft for supporting at least one axial row of radially directed blades through which the steam is expanded. A prestressed concrete inner casing structure of the turbine has upstream and downstream portions respectively situated upstream and downstream from the disc element. The radially outer surfaces of the inner casing portions and radially outer periphery of the axially interposed disc cooperatively form a downwardly radially inwardly tapered surface. An annular steam flowpath of increasing flow area in the downward axial direction is radially bounded by the inner and outer prestressed concrete casing structures. The inner casing portions each include a tranversely situated prestressed concrete circular wall for rotatably supporting the turbine shaft and associated structure.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 25325

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 25602, 25815, 26322

25662 **Solar energy thermalization and storage device.** McClelland, J.F. US Patent Application 061,321. [nd]. 9p.

A passive solar thermalization and thermal energy storage assembly which is visually transparent is described. The assembly consists of two substantial parallel, transparent wall members mounted in a rectangular support frame to form a liquid-tight chamber. A semitransparent thermalization plate is located in the chamber, substantially paralled to and about equidistant from the transparent wall members to thermalize solar radiation which is stored in a transparent thermal energy storage liquid which fills the chamber. A number of the devices, as modules, can be stacked together to construct a visually transparent, thermal storage wall for passive solar-heated buildings.

25663 (BNL—27661) **Development of a validated model of ground coupling.** Metz, P.D. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 7p. (CONF-800604—20). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

A research program at Brookhaven National Laboratory (BNL) studies ground coupling, the use of the earth as a heat source/sink or storage element for solar heat pump space conditioning systems. This paper outlines the analytical and experimental research to date toward the development of an experimentally validated model of ground coupling and based on experimental results from December, 1978 to September, 1979, expores sensitivity of present model predictions to(variations in thermal conductivity and other factors. Ways in which the model can be further refined are discussed.

25664 (BNL—27668) **Solar assisted heat pump studies: heat pump hardware and experiments, simulations, earth coupling contracts and supporting contracts.** Kush, E.A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 6p. NTIS, PC A02/MF A01.

The status of the heat pump hardware development contracts, the results to date of the BNL in-house heat pumps experiments, the progress of the contractural effort in earth coupling and the activities of various supporting contracts are summarized. (MHR)

25665 (CONF-790758—(Vol.II), pp 397-401) **90% solar heating and 70% solar cooling: Citizens Mutual Savings Association.** Perkins, R.M. (TEC Inc., Kansas City, MI). 1979.

From DOE regional solar update conference; Dearborn, MI, USA (11 Jul 1979).

The system incorporates 2220 sq. ft. of flat plate collectors, five water to air heat pumps with an outdoor cooling tower, and five solar heated absorption units for cooling. The system is expected to provide 91% of the heating and 70% of the cooling. The solar water storage is divided into two three thousand gallon tanks. (MHR)

25666 (CONF-7904119—) **Fourth annual conference on solar energy for heating of greenhouses and greenhouse-residence combinations.** Mears, D.R. (ed.). (Rutgers--the State Univ., New Brunswick, NJ (USA). Dept. of Biological and Agricultural Engineering). 1979. Contract FG01-79CS30022. 222p. NTIS, PC A10/MF A01.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Twenty papers are included. A separate abstracts was prepared for each paper (MHR)

25667 (CONF-7904119—, pp 1-8) **ERDA-USDA/SEA projects on solar heating and cooling of greenhouses and rural residences.** Zornig, H.F. (US Dept. of Agriculture, Clemson, SC). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Eleven current projects are summarized. A reference of project titles, locations principal objectives, and the names and telephone number of project managers is provided. (MHR)

25668 (CONF-7904119—, pp 9-18) **Construction and performance of greenhouse-residence prototypes SGR-2 and SGR-4.** Zornig, H.F.; Godbey, L.C. (US Dept. of Agriculture, Clemson, SC). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Some design details, construction problems, and operational results with SGR-2 and SGR-4, solar greenhouse-residence prototypes are included. Prototypes SGR-2 and SGR-4 were built much alike. The attached greenhouse is part of the solar system in each. Solar-heated air in the greenhouse is drawn through the flat plate collector and then through rock thermal storage before returning to the greenhouse. Heated air supplied to the house, either from thermal storage or from the auxiliary heating unit, returns through the greenhouse and then through thermal storage in the reverse direction. The solar-system problems and performance of SGR-2 are described because they were considered in the design of SGR-4. (MHR)

25669 (CONF-7904119—, pp 19-29) **Operation and performance of a hybrid solar greenhouse residence.** Davis, M.A. (Clemson Univ., S.C.); Ezell, D.O.; Godbey, L.C. 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

The research activities that pertain to the operation and performance of the thermal, mechanical, and architectural components of solar greenhouse-residence No. 3 are discussed. (MHR)

25670 (CONF-7904119—, pp 30-39) **Horticultural potential and operation characteristics of solar residence/greenhouse combinations.** Ezell, D.O.; Davis, M.A.; Zornig, H.F.; Sheeps, L.A. (Clemson Univ., SC). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Vegetables have been grown in 3 solar greenhouse redidences hereafter referred to as SGR-2, SGR-3, SGR-4, and a simulation site at the Clemson University Campus. The production research began in September 1977 in SGR-2, and other sites were added as completed. Research at SGR-2 was conducted with systems in operation but unoccupied. SGR-3 and SGR-4 residences have been occupied. Area of the greenhouses was 396, 300 and 248 sq. ft. respectively. The most recent prototype had ground beds along north and south walls. SGR-2 was located in a poor site for plant and solar performance due to large deciduous trees. SGR-3 was also located in a wooded site but sufficient trees were removed on the south slope to permit increased sunlight entry. SGR-4 location was an optimum location on a hilltop in full sun. Solar residence/greenhouse combinations have low night temperatures in the greenhouse and, as a result, reduced production. Plants grow slowly but do not seem to suffer otherwise. Humidity in such units appears adequate. Economics of such units remains unclear. It can be projected that the value of vegetables for home use will repay operating expenses. Payment of capital investment and interest is doubtful.

25671 (CONF-7904119—, pp 40-49) **Heat conservation and soil heating in a greenhouse/residence combination.** Smith, C.C. (Colorado State Univ. Fort Collins); Jurgrau, M.; Farrer, R.G. 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A solar heated greenhouse/residence combined structure has been in operation since Dec. 1976 at a site in north central Colorado. The two modifications introduced into full operation this year consist of night time insulative covers under the greenhouse glass roof and solar heating of the growing medium within the greenhouse. The latter technique has been demonstrated to lower the total heating consumption by setting back night space temperatures while maintaining equal production. Each of these modifications was carried out by two methods. The night time insulation was accomplished by insulation-filled window bays and by a curtain cover. Growing medium heating (soil heating) was done by heat transfer from embedded water pipes and by irrigation water heating, both from a solar heat source. This report deals with the description of these measures and their observed effects on heating energy performance and greenhouse productivity. (MHR)

25672 (CONF-7904119—, pp 50-60) **Operating performance of a solar aquaculture greenhouse.** Brown, E.; Straub, D.; Baylon, D.; Worthman, S. (Ecotope Group, Seattle, WA). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

The performance of a passive solar heated aquaculture greenhouse is evaluated. The efficiency of water tank storage and the effectiveness of a passive cooling stack are described. The maintenance of temperature difference between interior and ambient air temperatures are quantified. Aquacultural productivity is compared to growth rates reported elsewhere. The performance of an attached CO_2-producing composting system is evaluated. Problems with the greenhouse and the research efforts are described and solutions set forth.

25673 (CONF-7904119—, pp 61-72) **Q-Mats as passive solar collectors.** Albright, L.D. (Cornell Univ., Ithaca, NY) Seginer, I.; Langhans, R.W.; Donohoe, A. 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

One approach to the problem of energy storage in greenhouses is described. The energy conservation feature is a multilayer, highly insulated thermal blanket system developed during 1977-78. The passive solar system is based on water as a collection/storage medium. The water is stored in a series of inexpensive plastic bags named Q-Mats. (MHR)

25674 (CONF-7904119—, pp 73-82) **Performance of a collection/storage system for greenhouses.** Willits, D.H.; Chandra, P.; Miller, C.H. (North Carolina State Univ., Raleigh). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Work in greenhouse conservation centered around the development of a system for storing the excess energy collected in a greenhouse during the day and reclaiming it for use at night. The initial phase of the study involved the use of internal storage beds located under the benches. The results showed that while a savings of 12.9% was actually recorded for a two week period in January this could have been raised to 19.2% if enough storage volume had been available to accomodate all of the energy available. The development of external storages which can be added to existing greenhouses with minimal modification to the house itself was emphasized. Simulation models are currently being constructed and will be available soon. The construction and instrumentation of the system as well as some performance data from this past fall and early spring are covered. (MHR)

25675 (CONF-7904119—, pp 83-92) **Operation of a solar pond-to-greenhouse heating system.** Short, T.H.; Badger, P.C.; Roller, W.L. (Ohio Agricultural Research and Development Center, Wooster, OH). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A solar pond built at the Ohio Agricultural Research and Development Center (OARDC) during the summer of 1975 was designed to space heat up to half of an adjacent greenhouse. Another greenhouse of the same size and shape was heated with natural gas and compared to the solar-pond-greenhouse system. Since 1975 the solar pond has been modified to improve its reliability and efficiency and a polystyrene-pellet nighttime-insulation system is under development for greenhouses. This new combination may provide a surplus of heat for the solar heated greenhouse. However, some solar pond operational problems still exist and further technical development is required. (MHR)

25676 (CONF-7904119—, pp 93-103) **Energy conservation and solar energy utilization for greenhouses.** White, J.W.; Aldrich, R.A.; Sherry, W.J.; Mueller, C.A.; Milburn, W.F.; Kern, M. (Pennsylvania State Univ., University Park). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

The following are descussed: structural covering evaluations, high thermal resistance blankets, heat transfer through combined blanket-shell, solar heating systems, crop studies, and industry acceptance and use of project findings. (MHR)

25677 (CONF-7904119—, pp 104-117) **Performance of a solar energy heat collector and ground storage for heating a greenhouse.** Dale, A.C.; Turner, L.W. (Purdue Univ., Lafayette, IN). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

An insulated solar energy collector was fabricated with reflectors to concentrate the solar energy. The reflectors were placed at the top and bottom of the collector at such an angle so as to reflect additional solar energy into the collector to give a greater efficiency. Air served as the energy exchange medium between the collector and storage field of soil and groundwater at a depth of seven and nine feet for transfer of the heat to these materials. The collector was placed in operation in early July, 1978 to build up the stored energy for the fall and winter. In the late winter or early spring, cool air was circulated through the field to cool the storage. During the summer air is circulated through the storage field to provide cool air for ventilation and cooling of greenhouses. The growth and production rates of selected vegetabls and flowers were observed through the fall and winter seasons. Total effectiveness of the system was evaluated on the basis of measurements of the above factors. A view of the completed installation is shown. The general plan and cross section are shown. (MHR)

25678 (CONF-7904119—, pp 118-127) **Performance of the Rutgers solar heated greenhouse research units.** Simpkins, J.C.; Mears, D.R.; Roberts, W.J.; Janes, H. (Rutgers Univ., New Brunswick, NJ). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

The Rutgers solar heating system for greenhouses has been evaluated for another heating season. The components of the system have been modified and their improvements evaluated. New work has been initiated on the collection of solar energy inside the greenhouse. Two systems are under test, both of which circulate water through plastic film collectors inside the greenhouse with the

warmed water being stored in the floor system. Operation of the greenhouse solar heating demonstration project has provided for full scale testing of the components of the system. When scaling up in size from research prototype to full scale commercial systems, problems in the mechanical aspects of insulation and heat exchange curtains developed which are also being worked on in the research program.

25679 (CONF-7904119—, pp 128-136) **Experimental tests of a fluid-roof greenhouse concept.** van Bavel, C.H.M.; Sadler, E.J. (Texas A and M Univ., College Station). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

An experimental fluid-roof solar greenhouse was designed and constructed, specifically for the purpose of testing its principles of operation. These are: a) the interception of about half the solar radiation before it enters the greenhouse space and impinges upon the plant and ground surfaces and, b) the removal of the energy by the working fluid to a storage facility and its subsequent use or rejection during the night. The test consists of matching measured conditions in the experimental structure with numbers calculated from a model that embodies the above concepts. So far, the preliminary data confirm the calculations, though some improvements in the model are indicated. Experience suggests that the plumbing and circulation of a copper chloride solution present problems that must be solved prior to any practical application. (MHR)

25680 (CONF-7904119—, pp 137-141) **Construction of two solar energy heating systems for existing glass greenhouses.** WElls, J.M.; Baggett, H.V. (US Dept. of Agriculture, Byron, GA). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Construction of a solar hot water collector and storage system and a solar hot air collector and (gravel) storage system is complete. Each system has collector surface areas of 532 ft^2 and energy storage volume 266 ft^3, and will heat up to 1600 ft^2 of existing greenhouse facilities. Collector/greenhouse area ratios will be 1:1, 1:2, 1:3 depending on total greenhouse area selected for testing. Energy storage volume/collector surface area ratio will be 1:2. The design will permit controlled testing in matching greenhouse wings of 2 solar energy heating systems in comparison with conventional heating. Performance data will be collected during the winter of 1979-80.

25681 (CONF-7904119—, pp 142-151) **Inhouse solar collection for southern greenhouses.** Baird, C.D.; Waters, W.E. (Univ. of Florida, Bradenton). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A 1450 ft^2 glass aluminum greenhouse located at Bradenton, Florida, was retrofitted using the design shown. The attic collector consists of polypropylene shade cloth providing about 25% shade over the entire attic. Clear polyethylene was placed immediately below the shade cloth and sealed to the walls of the greenhouse to prevent air exchange between the attic and the plant growth area of the greenhouse. The rock bed located under the plant support benches consisted of approximately 10 tons of 1/2-inch river gravel with a bulk density of 103 pounds/ft^3. The rock bed was 18 in. deep, 40 in. wide, and 40 ft. long. In order to minimize resistance to air flow in the rock bed, a plenum was provided at the top and bottom of the bed causing air to flow vertically through the shortest dimension of the bed. Forcing air through the 40-foot dimension of the bed would be impractical due to the high pressure loss through the rock. The use of larger rocks will result in less pressure drop but the 40-foot path would still require too much fan power. Also, when large rocks are used on must be concerned with the time lag in transferring heat to and from the rocks due to the internal resistance to heat flow. Concrete blocks with a small space between each are used as the air duct on the bottom of the bed. Blocks also provide additional thermal storage.

25682 (CONF-7904119—, pp 152-160) **Solar membrane greenhouse: winter performance.** Droll, P.W.; Tilford, C.L. (Suntek Research Associates, Corte Madera, CA). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A large quonset style greenhouse, which was used the previous five years for the production of fresh market tomatoes, was modified by installing on the inside surface of the original corrugated fiberglass covering three air separated layers of a material called Solar Membrane. A large above ground rock storage bin external and to the rear of the structure was constructed to accept excess heat normally vented to the outside during clear sunny days. The energy collected is stored in the rock bed as sensible heat and is used to maintain operating temperatures during the nighttime periods. Engineering data have been obtained for approximately one year and are reported. The data indicate that during that time period the gas consumption was reduced by 70%, the electricity use increased by 6%, and the overall utility costs were reduced by 41%. A mathematical model which has been verified using actual performance data has been used as a design tool to indicate mechanical changes which would improve thermal performance.

25683 (CONF-7904119—, pp 161-166) **Operations experience commercial hybrid solar greenhouse.** Collins, D.L. (Solargenics, Inc., Chatsworth, CA). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

Performance evaluation of the solar heated greenhouse has been divided into separate functional groups so that the independent impact of each group can be assessed accurately. Solargenics constructed its own instrumentation system since no cost-effective system with real-time operational readout was available. Data verification is essential to good long-term operational analysis. The present instrumentation system allows examination of each data channel as seen by the A/D converter, as well as providing incremental, hourly, and daily summary reports. The first baseline evaluation element was the active solar system. This element includes collectors, field piping, packaged solar mechanical equipment back-up epuipment, uni-temp radiators, and all associated controls. The actual equipment performance was compared with the computer-generated performance baseline. To date the data of actual versus computed performance tracks within acceptable limits. Work is now proceeding with operational evaluation of the heat recovery system. This system consists of a multifunctional rock storage bin, a unique stratification barrier, and related ducts, dampers, blowers, and controls.

25684 (CONF-7904119—, pp 167-173) **Commercial greenhouse solar system performance.** Staton, B.G. (Lockheed-Huntsville Research and Engineering Center, Huntsville, AL). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A solar heating system constructed at the Ulery Greenhouse Company in Springfield, Ohio is described. The Ulery complex includes approximately nine acres of greenhouses where seasonal pot plants, green foliage plants and spring bedding plants are grown. Their greenhouses are heated with both steam and hot water systems using natural gas or oil as fuels. The present fuel cost for heating is running approximately $1.00 per square foot of greenhouse floor space. A solar system was designed and constructed to provide approximately 60 percent of the heating energy to a 8650 ft^2 greenhouse. Six-thousand square feet of flat plate collectors were installed in place over four rows of wooden support structures. Hot water from the thermal storage tank is pumped into the greenhouse for heating purposes.

25685 (CONF-7904119—, pp 174-184) **Monitoring of the solar heating of a commercial greenhouse.** Cummings, R.D. 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A solar heating system to heat a commercial greenhouses was constructed. MSD has now started the process of monitoring the performance of this system and will continue performance monitoring over a two-year period. The system is a single cavity receiver of 500 Ft^2 gross area. The operating principles of the system are depicted. The greenhouse heated is a 15,000 Ft^2 glass greenhouse, presently poly-covered, and utilizing oil heat with a heating system of 7,000 BTU/hour capacity. (MHR)

25686 (CONF-7904119—, pp 185-195) **Performance of the Kube Pak solar heated greenhouse.** Mears, D.R.; Roberts, W.J.; Kendall, P.W.; Cipolletti, J.P. (Rutgers Univ., New Brunswick, NJ). 1979.

From 4. annual conference on solar energy for heating greenhouses and greenhouse-residence combinations; Piscataway, NJ, USA (1 Apr 1979).

A 58,000 ft^2 greenhouse addition using 11,000 ft^2 of inflatable plastic collector is described. This program was geared to low initial cost systems for applications with commercial double-covered polyethylene structures. The system description, construction, costs, and performance are presented. (MHR)

25687 (DOE—5229-T1) **Farallones Institute solar data package and performance analysis.** Calthorpe, P. (Farallones Inst., Berkeley, CA (USA); Berkeley Solar Group, CA (USA)). 30 Jan 1980. Contract EM-78-G-01-5229. 134p. NTIS, PC A07/MF A01.

The passive solar test units, small cabins of 285 ft^2 each, were constructed in Sonoma County, CA, in order to study, on a comparative basis, different generic forms of passive solar space heating systems. The cabins were built using standard wood framing construction methods and the building itself acts as collector and storage

container. This study has recorded and analyzed, for the winter 77-78, the performance of these four cabins and provides information about their individual subsystems as well as the full systems' comparative strengths and weaknesses. The generic forms studied were direct gain, indirect gain, and isolated gain. (MHR)

25688 (DOE/CS/30169—1) **Suncatcher Monitoring Project. Quarterly technical report, January-June 1979.** Maeda, B.T. (Davis Alternative Technology Associates, CA (USA)). 8 Mar 1980. Contract FG02-79CS30169. 76p. NTIS, PC A05/MF A01.

Data gathered on a daily basis and work done on the data acquisition system to correct data gathering mechanical and electronic problems are presented. (MHR)

25689 (DOE/CS/30238—T1) **Investigation of passive cooling for hot-humid climates. Progress report No. 3.** Akridge, J.M. (Georgia Inst. of Tech., Atlanta (USA). Coll. of Architecture). 29 Apr 1980. Contract AC02-79CS30238. 13p. NTIS, PC A02/MF A01.

Work on getting the Brookhaven National Laboratories computer program for modeling ground coil performance operational is described. Arrangements made to sink two 40 ft vertical wells for soil temperature measurements are described. Methods for evaluating the effect of pipe diameter, length, spacing, and material were investigated. Calculation results are shown. (MHR)

25690 (DOE/CS/30242—3) **Passive solar heating of buildings with attached greenhouse. Progress report, February 29, 1980-April 29, 1980.** Jones, R.W. (South Dakota Univ., Vermillion (USA)). Apr 1980. Contract AC02-79CS30242. 28p. NTIS, PC A03/MF A01.

Research is being conducted on the attached-greenhouse type of passive solar heating system in the north-central region. The thermal performance of attached-greenhouse buildings is being analyzed in order to determine the component sizes and configurations which optimize performance. The analytical method is dynamic computer simulation using a thermal network model and actual hourly meteorological and solar radiation data from the north-central region. Progress in this, the third quarter, of the project has consisted of a large number of additional computer simulation runs and resulting performance estimates for certain designs. Conclusions on design guidelines are emerging from the results. The overall aim of the project is the development of specific design guidelines useful to architects and builders.

25691 (DOE/CS/31589—2) **Dynamic performance characterization of bound, porous silica gel desiccant.** Onischak, M.; Gidaspow, D.; Perkari, S.; Sasaki, T. (Illinois Inst. of Tech., Chicago (USA)). Oct 1979. Contract EG-77-C-03-1589. 65p. (DES—79-1). NTIS, PC A04/MF A01.

Drying of air with silica gel is a well established procedure. However, for the specific use of silica gel in a novel desiccant air conditioning system, which continually cools the silica gel and utilizes solar energy for silica gel regeneration, conventional packed bed devices are not suitable. For this system to operate effectively the silica gel must not rise in its temperature or its capacity will be greatly diminished. Dynamic dehumidificatuion performance was investigted for a silica gel desiccant fabricated in bound, porous paper-like sheets. Sheets of various thickness (0.7 to 3 mm) were fabricated and tested under several dynamic flow conditions in a flat rectangular channel apparatus. During each experiment conditions of inlet moisture, air flowrate, and sheet temperature were maintained constant. Comparisons were also made with conventional silica gel pellets and with other forms of bound silica gel. The sheets show superior utilization of silica gel in short times (30 minutes or less). Tests were also made to examine the sheet structure in order to explore the effect of temperature on the porous structure, and to obtain pore size distributions.

25692 (DOE/CS/31589—3) **Cross-cooled dehumidifier model test results and computer simulations.** Mei, V.; Lavan, Z. (Illinois Inst. of Tech., Chicago (USA)). Nov 1979. Contract EG-77-C-03-1589. 59p. (DES—79-2). NTIS, PC A04/MF A01.

Research on the development of a solar operated cross-cooled desiccant cooling system is described. A 15 cm x 15 cm x 15 cm (6" x 6" x 6") cross-cooled silica gel desiccant dehumidifier model was designed, built and tested. The process of producing the silica gel sheets, the design and construction of the unit, the test setup and the test procedures are described in detail. A total of twenty tests were performed to determine the effect of inlet process stream dew point, process stream and cooling stream flowrates and regeneration stream temperature and dew point, on the performance of the unit. The test results show that the unit performance improves with increasing regeneration temperature, process stream flowrate and process air inlet dew point. The unit performance decreases with increase of the regeneration stream dew point. The results clearly show that the process stream inlet dew point is the dominating factor and that the concept of cross-cooling works very well. With moderate cross-cooling, the unit performance can increase over 50%. All tests were simulated by a computer program. The experimental and theoretical results are in very good agreement.

25693 (DOE/NASA/CR—161422) **Solar heating and cooling system design and development. Final report.** (General Electric Co., Philadelphia, PA (USA). Space Div.). Oct 1979. Contract EX-76-A-29-1037; EY-76-C-02-2683. 109p. NTIS, PC A06/MF A01.

This project involved the complete design and development of marketable systems for single-family and commercial applications and the delivery, installation, and monitoring of the prototype systems. The program plan, description of systems, including components and their applications, seven operational test sites, system performance and comparisons, and lessons learned are presented. (MHR)

25694 (DOE/NASA/CR—161435) **Solar heating system installed at Blakedale Professional Center, Greenwood, SC Final report.** (Gilbert (W.E.) and Associates, Inc., Greenwood, SC (USA)). Mar 1980. Contract EX-76-C-01-2389; EX-76-A-29-1024. 50p. NTIS, PC A03/MF A01.

Information is provided on the solar heating system installed at the Blakedale Professional Center, in Greenwood, South Carolina. The information consists of site and building description, solar system description, performance evaluation, system problems, and installation drawings. The solar system was designed to provide approximately 85% of the building's heating requirements. The system was installed concurrently with building construction and heats 4440 ft^2 of the building. There are 954 ft^2 of liquid flat-plate collectors that are roof-mounted and have a drain-down system to protect the collectors from freezing. A 5000 gal steel, polyurethane insulated tank buried underground provides storage. The system was fully instrumented for performance evaluation and integrated into the National Solar Data Network.

25695 (DOE/R5/10122—1) **Demonstration of an advanced solar garden with a water ceiling. Six-month technical progress report, July 1-December 31, 1979.** Maes, R.; Riseng, C.; Thomas, G. (Environmental Research Inst. of Michigan, Ann Arbor (USA)). Feb 1980. Contract FG02-79R510122. 27p. NTIS, PC A03/MF A01.

A history of the solar garden with the addition of the transparent water ceiling and a statement of the overall goals of the program are presented. It then details the objectives of the water ceiling grant. The rationale of the transparent water ceiling is developed and its implementation in the solar garden is described. The experimental procedures for evaluating the water ceiling as an integral part of an ongoing garden agricultural experiment are discussed. The results of the first six months of the program and the future activities of the next period are presented.

25696 (DSE—4218-T1) **Solar heating and cooling commercialization research program. Final report.** Christensen, D.L.; Tragert, W.; Weir, S. (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Nov 1979. Contract EM-78-S-01-4218. 133p. NTIS, PC A07/MF A01.

The Solar Heating and Cooling Commercialization Research Program has addressed a recognized need to accelerate the commercialization of solar products. The development of communication techniques and materials for a target group of heating, ventilating and air-conditioning (HVAC) wholesalers and distributors has been the primary effort. A summary of the program, the approach to the development of the techniques and materials, the conclusions derived from seminar feedback, the development of additional research activities and reports and the recommendations for follow-on activities are presented. The appendices offer detailed information on specific elements of the research effort.

25697 (DSE—5235-T1) **Monitoring of the performance of a solar heated and cooled apartment building. Final report.** Vliet, G.C.; Srubar, R.L. (Texas Univ., Austin (USA). Center for Energy Studies). Mar 1980. Contract EM-78-S-01-5235. 95p. NTIS, PC A05/MF A01.

An all-electric apartment building in Texas was retrofitted for solar heating and cooling and hot water. The system consists of an array of 1280 square feet of Northrup concentrating tracking collectors, a 5000-gallon hot water storage vessel, a 500-gallon chilled water storage vessel, a 25-ton Arkla Industries absorption chiller, and a two-pipe hydronic air conditioning system. The solar air conditioning equipment is installed in parallel with the existing conventional electric heating and cooling system, and the solar domestic water heating serves as preheat to the existing electric water heaters. The system was fully instrumented for monitoring. Detailed descriptions are given of the solar system, the performance monitoring system, and the data reduction processes. Results are presented and discussed. (WHK)

25698 (EMD—80-41) **Federal demonstrations of solar heating and cooling on commercial buildings have not been very effective.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 15 Apr 1980. 46p. General Accounting Office, 441 G St., NW, Washington, DC.

Report to the Congress of the United States by the Comptroller General.

An analysis is provided of the commercial buildings solar heating and cooling demonstration program implemented by DOE. A discussion of the objectives of the law authorizing the program and an evaluation of the success of the program in meeting those objectives are included. Practicality, data dissemination, and development of a viable solar industry are discussed. (MHR)

25699 (EPRI-EM—1363) **Individual load center: solar heating and cooling commercial project. Final report.** (Little (Arthur D.), Inc., Cambridge, MA (USA)). Mar 1980. 80p. NTIS, PC A05/MF A01.

Phase 2 - Detailed Design Activities - of EPRI Research Project RP844 (Individual Load Center-Solar Heating and Cooling Commercial Project) is now complete. This phase began with the conceptual design of solar/load-management systems for six commercial buildings in both new and retrofit applications. The six buildings included offices, schools, a credit union, and a delicatessen. Through the detailed design effort, these preliminary renderings were carried to the stage of drawings and specifications suitable for inclusion in a bid package. Most of the detailed design effort was spent performing parametric studies of system performance using simplified models of the building and of its heating and cooling equipment. These performance studies were interspersed with projections of both cost and experiment content to ensure compliance with budgetary constraints and to promote the maximum informational value of the project. Final design in each case was consigned to a designated consulting engineer in the locale of the experiment. Because of the complexity of each project and the number of parties involved (utility, building owner, equipment contractors, general contractor, EPRI, etc.), considerable effort was expended in drawing up legal agreements for each of the six projects.

25700 (EPRI-ER—1239(Vol.2)) **Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring insruments: selection, calibration, and installation. Final report.** Armstrong, P.R. (Altas Corp., Santa Cruz, CA (USA)). Nov 1979. 221p. NTIS, PC A10/MF A01.

Volume 2 is concerned with measurements needed to assess the thermal performance of solar heated or cooled buildings. It is a handbook of measuring functions and principles. Transducers most ppropriate for SHACOB monitoring are discussed in detail. These include, for temperature: semiconductor sensors, thermistors, and thermopiles (a new thermopile sensitivity function if presented); for flow: positive displacement and propeller meters with pulse train outputs and heated sensor probes; and for insolation: thermopile and photovoltaic pyranometers. The measurements of conncern in passive buildings: heat flux, temperature-time trajectories and mean radiant temperature; and the measurements generally needed to compute thermal capacitance rates in air systems: pressure and humidity; are also discussed. Calibration, installation, and signal interfacing considerations are reviewed. Special techniques for measuring fluid flows and enthalpy rates associated with fluid flows (using Btu meters) are described and some new designs proposed. Also presented are a transducer selection procedure, an analysis of sampling error and error propagation, and a review of grounding and shielding practice.

25701 (EUR—6681/I-EN) **Solar energy applications for dwellings; modelling and simulation part. Final report.** Joergensen, O. (Danmarks Tekniske Hoejskole, Lyngby). 1980. 109p. NTIS (US Sales Only), PC A06/MF A01.

A comparison of methods for predicting the performance of solar heating systems has been coordinated within the CEC Solar Energy R and D program. The methods which are developed within the EC countries are presented and compared in this report. The methods have been used to predict the performance of three different solar heating systems: a domestic hot water system, a pure house heating system, and a combined system. Three different sets of weather data have been used: Carpentras, Hamburg, and Ireland. The comparisons have been undertaken on three different timebases: yearly, monthly, and hourly. A sensitivity analysis has been performed on different parameters by different programs.

25702 (LA-UR—80-1076) **Passive solar space heating.** Balcomb, J.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 11p. (CONF-800604—11). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

An overview of passive solar space heating is presented indicating trends in design, new developments, performance measures, analytical design aids, and monitored building results.

25703 (LA-UR—80-1080) **Design of an atrium for a passive-solar retrofit of an office buildings.** Peterson, J.L.; Hunn, B.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800604—13). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The Los Alamos Scientific Laboratory (LASL) has proposed to retrofit one of its administrative office buildings with a solar atrium. A 334 m^2 courtyard will be enclosed with a roof-mounted system of clerestory windows to maximize winter solar gain. This sunspace will thermally buffer the adjoining offices and also will preheat air supplied to the building's conventional heating, ventilating, and air-conditioning (HVAC) system. The use of the DOE-2 building energy analysis computer program in the design of the solar atrium is described. The results of a series of simulations are reported detailing the tradeoffs inherent in the selection of an optimal glazing area, the maintenance of acceptable comfort levels within the sunspace, and intergration of passive-solar devices with the conventional HVAC system. Potential energy savings are also discussed.

25704 (LA-UR—80-1087) **Evaluation of passive solar retrofit options.** Ben-David, S.; Kirchemen, C.; Martin, S.; Noll, S.; Roach, F. (New Mexico Univ., Albuquerque (USA). Dept. of Economics; Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800604—12). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

An evaluation framework has been developed which allows for the assessment of the role of passive solar retrofit in the nationwide reduction of conventional fuel use. Three types of analysis are proposed within this framework: the physical/technical capability of the present housing stock to incorporate passive solar retrofit; the economic feasibility of the application of retrofit designs; and the actual market potential or acceptance of these alternative retrofit options. Each type of analysis has specific data requirements and a series of evaluation procedures to help establish estimates of the potential for passive solar retrofit in the present housing stock. The data requirements with their respective sources and evaluation procedures for the first two types of analysis-physical/technical setting and economic feasibility, are examined. A distinction is drawn between community specific case studies and more generalized national assessments. Information derived from these three types of analysis, whether case specific or national in scope, can then be used in an evaluation of potential economic impacts. The establishment of regional economic benefits and costs werve as a measure of the merit or attractiveness of the implementation of a passive solar retrofit program.

25705 (LBL—10716) **Evaluation of control strategies for solar collector loops.** Warren, M.L.; Schiller, S.R.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 15p. (CONF-800604—22). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The performance of proportional and on/off controllers are evaluated and compared using a theoretical dynamic collector model. The experimental test facility of Lawrence Berkeley Laboratory is also discussed. Both the model and test facility allow the evaluation of control strategies using various flow rates, controller set points, insolation patterns, ambient temperature conditions, and collector types. The test facility also allows the comparison of collector and load loop flow strategies based on various system configurations and building load demands. The experimental tests and model simulations can be used to evaluate and compare control strategies using performance indicators such as: energy collection efficiency, parasitic power consumption, pump cycling, and auxiliary heat usage.

25706 (NP—24443) **Reporting format for thermal performance of solar heating and cooling systems in buildings.** Isakson, P.; Kennish, W. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden); TPI, Inc., Beltsville, MD (USA)). Feb 1980. 58p. NTIS (US Sales Only), PC A04/MF A01.

The following are presented: the reporting format, description of the surrounding environment, description of the overall system, system operation, thermal performance evaluation program, description of operation period, performance results, and economics. (MHR)

25707 (SERI/TP—245-430) **Solar heating and cooling systems: operational results.** (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 367p. (SOLAR/0500—80/00; CONF-791105—). NTIS, PC A16/MF A01.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Forty-six papers are included. One paper was abstracted previously. Separate abstracts were prepared for each paper. Summary reviews of each session and the introductory remarks were not abstracted. (MHR)

25708 (SERI/TP—245-430, pp 85-97) **Results of performance analysis of passive systems in the National Solar Data Network.** Weston, M.W. (IBM Corp., Gaithersburg, MD). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The National Solar Data Network, as a part of the National Solar Heating and Cooling Demonstration Program, provides a means for the collection and analysis of data representing the thermal performance of selected instrumented solar energy systems. Among the systems for which data is being collected and analyzed are those systems utilizing passive techniques for space heating. This paper presents an overview of the thermal performance results for selected instrumented passive systems in the National Solar Data Program. System thermal performance is illustrated both in terms of energy utilization and savings and in terms of thermal comfort. Solar energy system characteristics which contribute to the sucess of the systems are discussed.

25709 (SERI/TP—245-430, pp 99-105) **Performance data evaluation of the Balcomb solar home (SI Units).** Balcomb, J.D.; Hedstrom, J.C.; Moore, S.W. (Los Alamos Scientific Lab., NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Heating season performance data are developed for the Balcomb solar home for the period Novermber 1, 1978 through April 24, 1979. The home is a two-story attached solar greenhouse with a total area of 214 m^2 located in Santa Fe, New Mexico. The measured loss coefficient for the house is in good agreement with the predicted value. The useful solar heat averaged over the season is 301 MJ/day corresponding to 88.3% of the net load and 37.4% of the solar radiation incident primarily as heat storage for the greenhouse but is less effective than expected in heating the living areas. The fan-forced rock bed is quite effective, having an overall COP of 11. Energies transported by convection, though not measured directly, are determined by indirect techniques and are found to be quite significant. The need for instrumentation to better understand convective energy flows is discussed.

25710 (SERI/TP—245-430, pp 107-111) **Solar classroom at Hamilton College.** Ring, J.W.; Hamilton, A.M. (Hamilton College, Clinton, NY). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The performance of a simple, passive, solar building in the cold, cloudy climate of upstate New York has been tested over two heating seasons: 1977-78 and 1978-79. The thermal conductance of the building has been found to be 112.4 x 10^3J/DD(°C) (590BTU/DD(°F)) and the sun's contribution to heating the building has been found to be 69% the first year and 66% the second. The thermal storage is sufficient to provide for several days carry-over and also serves to keep the temperature swings within comfortable limits. Simple steps which might improve this performance to a 85% contribution by the sun are suggested.

25711 (SERI/TP—245-430, pp 113-118) **Results from a passive thermal storage roof on a mobile/modular home in Los Alamos.** Balcomb, J.D.; Hedstrom, J.C.; Moore, S.W.; McFarland, R.D. (Los Alamos Scientific Lab., NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Heating season performance data are developed for the LASL Mobile/Modular II home for the period October 1978 through May 1979. The building was constructed in two sections with a combined floor area of 101 m^2 and transported to Los Alamos, New Mexico. The design incorporates a series of four clerestory windows across the roof, hinged insulation panels located within the clerestory space, and water in plastic bags as the heat storage. The heat storage roof seems to be effective thermally but was overpowered by direct gain through south windows during the early part of the heating season, tending to overheat the space. During the latter part of the season these windows were blocked with insulation greatly reducing temperature swings without apparent reduction in performance. The useful solar heat averaged over the season is 166 MJ/day corresponding to 80% of the net load and 23.5% of the solar radiation incident on the glazing.

25712 (SERI/TP—245-430, pp 119-124) **Thermal performances of solar energy space heating subsystems.** Skidmore, R.S.; Smok, J.T. (IBM Corp., Gaithersburg, MD). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The space heating performance of five National Solar Data Program (NSDP) demonstration sites during the winter of 1978-1979 is presented. The geographical location of the five installations evaluated vary from Virginia to Wisconsin; the energy transport mediums include air and liquid; one system provides solar energy to a school gymnasium, another to a single-family home. These differences provide the basis for a comparative analysis of solar energy space heating subsystems. The differences notwithstanding, there are underlying similiarities which yield an increased understanding of solar energy system performance. For the five sites in total, approximately 25 percent of the available solar energy was collected and once collected, upwards to 80 percent (of the collected energy) was usefully consumed. The solar fractions, however, vary from 13 percent to 78 percent. An explanation of this variation is found in the arithmetic ratio of heating load to solar energy available - the lower the heating load as a percent of solar energy available, the greater the solar fraction. Based upon an analysis of the five sites reviewed, the overall effectiveness of a solar energy space heating subsystem will be governed by the collector array performance and not by specific space heating methods or designs.

25713 (SERI/TP—245-430, pp 125-130) **Thermal performance of a commercially available state-of-the-art solar air-heating system.** Karaki, S.; Waterbury, S.; Lantz, T. (Colorado State Univ., Ft. Collins). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Performance of a state-of-the-art air-type slar heating system in CSU Solar House II is evaluated for the 1978-79 heating season. The system includes 32 modules (57.9 m^2) of Solaron series 3000 collectors, two blowers (one to collect and store solar heat and a second to distribute thermal energy from storage), 103 m^2 of pebble bed storage, domestic water preheating capability, and a 3-ton Carrier air-to-air heat pump for auxilary space heating. An average daily collection efficiency of 33 percent was achieved, with operating collection efficiency of 38 percent (based on solar irradiance while the system was operating). Overall solar COP for useful heat delivered to space and hot water was 13.5 consisting of COP for collection of 26.3 and COP for distributing solar heat of 36.0. Average heating COP for the heat pump is required only after solar storage is nearly exhausted, hence it operates when ambient air temperature is low.

25714 (SERI/TP—245-430, pp 131-135) **Air leakage effects on active air-heating solar collector system performance.** Jones, D.E.; Shaw, L.E.; Loef, G.O.G. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Air leaks into air-based solar-heating systems are a reality and it does not appear that total elimination of the leaks is economicaly feasible or desirable in some applications. A method is presented of determining the worst case effect of collector duct leakage on instantaneous system performance and suggests a procedure for estimating the worst case effect of leakage on long-term performance. Although air leaks into a collector array can be beneficial in some applications, depending on the nature of the load, analysis is carried out in this paper without these beneficial effects included.

25715 (SERI/TP—245-430, pp 137-145) **Performance of solar energy systems in the residential solar demonstration program.** Freeborne, W.E.; Mara, G.; Lent, T. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Performance information derived from the instrumentation of twenty-three solar projects built in the Residential Solar Demonstration Program is analyzed. Four exercises were performed on data supplied by instrumentation. 1. The apparent solar fraction was calculated by dividing the measured solar contribution by the sum of the measured solar contribution and the measured auxiliary thermal output energy. 2. The measured electric or fossil input was compared with the home's predicted electric or fossil input assuming solar performs as expected. 3. Measured losses from solar energy storage and transport subsystems were tabulated and the effects of adding measured losses to the measured solar contributions were calculated. 4. The measured electric or fossil input was compared with the home's predicted conventional energy use assuming no solar contribution. The results are presented and discussed.

25716 (SERI/TP—245-430, pp 151-155) **Solar heating results for the Nambe Community Center.** Murray, H.S.; Hedstrom, J.C.; Moore, S.W. (Los Alamos Scientific Lab., NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The Nambe Community Center is a solar heated abobe community building for the Nambe Indian Pueblo, located twenty miles north of Santa Fe, New Mexico. The 279 m^2 building makes use of several passive solar heating features. The active solar heating system is an air system using a 15,420-kg rock storage bed. The solar collector system consists of a 41 m^2 vertical collector with a 98 m^2 reflector. The system also allows night evaporative cooling of the rock bed for summer cooling operation. The heating season of 1978-79 was the first full season of operation for which complete operational data were obtained. These results are presented along with a discussion of the use of the rock bed for summer night cold storage.

25717 (SERI/TP—245-430, pp 163-166) **Performance of the Sunearth House.** Shippee, P. (Colorado Sunworks, Boulder). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Minimal energy use in buildings is successfully demonstrated in the SunEarth House. This house is an earth-covered passive solar heated and naturally cooled residence located in Longmont, Colora-

do. It was designed, built, and marketed by Colorado Sunworks in 1977-78. Performance is monitored by IBM computerized tracking of 90 energy sensors placed in the building during construction. Performance reports are published by the Department of Energy under the National Solar Data Program. During the winter of 1978-79 the house was considered to be 100% solar heated because the occupants turned off the furnace pilot light and left it off.

25718 (SERI/TP—245-430, pp 173-177) **Energy usage of an energy efficient, solar heated house.** Kent, A.; Ohadi, M. (Southern Illinois Univ., Carbondale). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

An energy efficient, solar assisted house was built in a small midwestern rural community where the sun shines slightly less than half the time in the winter. The premise was an energy efficient, solar assisted house would attract buyers, even in a conservative community. The house is designed for minimum air conditioning and best use of passive solar heating in a low thermal mass structure. The basic construction and temperature variations, energy consumption and hours of equipment operation. Building thermal monitored for temperature variations, energy consumption and hours of equipment operation. Building thermal characteristics from these data are reported. The building heating and cooling requirements are calculated, along with solar contribution. These values are compared with monitored data. The heating season is reduced from 8 to 5 months; the energy required is calculated to be 32 percent of a HUD-MPS (1977) house. The air conditioner was only operated 40 hours this summer.

25719 (SERI/TP—245-430, pp 189194) **Lumsdaine solar house.** Lumsdaine, E.; Lumsdaine, M. (New Mexico State Univ., Las Cruces). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Summer and winter data are summarized for the Lumsdaine solar house in Las Cruces, New Mexico. The house has a modified building heat loss coefficient of 0.11 MJ/m^2-D.D.(°C) or 5.4 Btu/D.D.-ft^2 for a total heat loss of 52,800 MJ (50.2 MBtu) per year. At worst, the house has an auxiliary heat requirement equivalent to 1100 kWh/year. Heating is about 75 percent by passive solar (direct gain and atrium) and 20 percent by ahybrid solar roof system. Thermocouple data for the solar roof system in the heating and cooling mode and air and surface temperature data in graphical and tabulated form are presented. Operational experience is also discussed as well as construction problems and solutions. Total energy consumption for the house is around 10,000 kWh/year (refrigerator/freezer = 30%, cooking, lights, appliances = 40%, solar roof system fans and solar water heater = 15%, backup water heater = 15%). Power demand is less than 2 kW except for a peak of about 4 kW during late evening hours; thus this house does not contribute to the summer peak load problems of the utility.

25720 (SERI/TP—245-430, pp 195-198) **Low cost retrofit solar home for demonstration and consumer acceptance experiments.** Goswami, D.Y.; Klett, D.E. (North Carolina Agricultural and Technical State Univ., Greensboro). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Recognizing the need for a retrofit solar system for demonstration in the Piedmont Region of North Carolina and the need for studies on consumer attitudes towards acceptance of retrofit solar use, a project was undertaken to retrofit the University's existing two-story Home Management House. The solar system consists of active solar water heating and passive space heating. Two collectors (55 sq. feet area) for the water heating system were fabricated on site, using 2 in x 6 in pine joists, EPDM absorber extrusion, Urethane insulation boards, polycarbonate double wall extruded Tufax-Twinwall glazing and copper headers. The collectors and easy to construct and low-cost ($5.50-6.00/sq. ft.) The thermostat in the storage tank is set at 100°F so that it seldom comes on. If needed, an in-line demand heater raises the temperature of the water to the required level only when the water is being used. A large solar greenhouse (22 ft x 10 ft x 12 ft) attached to the southern side of the house provides the passive heat gain which is supplemented by a wood stove and the existing gas heating system of the house. The system is economical and ideally suited for retrofitting.

25721 (SERI/TP—245-430, pp 199-201) **Economics of heating Maryland broiler houses with solar energy.** Cain, J.L.; Felton, K.E.; Brinsfield, R.B. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Heating costs for broilers were compared, during 1978, between a solar energy system and conventional (propane) heating at the Environmental Research's Broiler Facilities of the University of Maryland's Poultry Research Farm in Salisbury, Maryland. Both series of test flocks utilized the limited area brooding concept. Heating cost per 1000 broilers for the conventional system was $13.54 and for the solar system was $54.43. Low utilization of relatively high fixed cost solar facilities due to current management practices caused the sizeable difference in cost. Finding alternative uses for the overflow energy from the solar system and reducing fixed cost of solar facilities are the eyes to economic feasibility of solar energy in broiler production.

25722 (SERI/TP—245-430, pp 203-209) **Use of operational results to identify potential improvements in the thermal performance of air solar heating systems and to establish performance criteria.** Shingleton, J.G. (Mueller Associates, Inc., Baltimore, MD); McCabe, M.E. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The National Bureau of Standards is developing definitive performance criteria for solar heating, cooling, and hot water systems. This study was performed to quantify the effect of air leakage on the thermal performance of air type solar heating systems. Field air flow measurements taken at seven instrumented residential air type solar heating systems show substantial air leakage. A TRNSYS computer model was developed based on the system at one instrumented site where air flow measurements were taken. Air leakage from this system had been reduced as much as possible. The effect of air leakage on system performmance was examined analytically by including the measured air leakage in the system model. The results of the computer simulations show that by eliminating all of the measured air leaks that remained after the modeled system was repaired, a reduction of as much as 19 percent in seasonal auxiliary energy can be realized. The relationship between air leakage and auxiliary energy use in this system is described.

25723 (SERI/TP—245-430, pp 211-216) **Overview of field experience with three active solar commercial buildings.** Rouzer, C.W.; Busch, R.D. (Bickle/CM Inc., Albuquerque, NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Three projects are described to provide insight into the evolution of solar utilization. Experience from the first project identified materials and equipment specification problems which were resolved in the next generation design. Installation or maintenance problems for these designs detracted from system performance until they were corrected. Utilization of field experience and knowledge obtained from past problems - solutions provided an effective solar system for present design stage evolution which exceeds design performance estimates. Proper selection of materials combined with field experience in design and installation creates high efficiency systems in energy conservation buildings which are affordable, effective, and reliable.

25724 (SERI/TP—245-430, pp 217-221) **Design and operational results of a solar space heating system.** Swindle, E.M. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

This is a disclosure of a space heating system that features a simple approach for capturing solar energy - a water drain back technique which is fail-safe from freezing and does not have any valves or special venting in the collector loop. Eight systems have been installed with this drain back idea; the original has been in service for more than 3 years with sub-freezing winters. The system discussed here is a retrofit for a 60-year old wood frame home. The solar collectors and storage systems were necessarily installed on a out building located 100 feet from the home. Included here will be problems and lessons learned, but will emphasize the design, installation, instrumentation, and performance stated in lay terms.

25725 (SERI/TP—245-430, pp 223-229) **Passive energy design and habitability aspects of earth sheltered housing in Oklahoma.** Boyer, L.L.; Grondzik, W.T.; Weber, M.J. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Identified earth sheltered houses in Oklahoma were examined through a detailed questionaire during the first phase of a long-range funded project. Preliminary results of energy and habitability aspects are presented herein. Saving energy is reported to be the primary incentive for building such structures. Habitability aspects have generally not received much study until very recently. Results indicate that although a majority of the respondents feel their energy savings expectations have been reached, over 40 percent feel that their energy consumption is much higher than they expected. Preliminary energy performance studies indicate that in a majority of the projects, the potential thermal mass of the structure has been decoupled by insulation and furred interior surface treatments. This situation can lead to a significant reduction in the amount of the free earth cooling available during the summer months. Other factors, not yet studied, undoubtedly contribute additional adverse effects. Of considerable interest is the finding that the substantial energy savings that are realized have been achieved with little decrease, and often an increase, in comfort and habitability aspects. Most occupants are particularly satisfied with the safety of the structure and

the arrangement of the rooms, which in most cases were custom designed by or for the occupants. However, daylighting and privacy of family members, for example, were not as highly rated.A number of other parameters are identified from the survey which present implications for design enhancement in this contemporary type of residential structure.

25726 (SERI/TP—245-430, pp 231-235) **Solar analysis based on utility bills.** Sparkes, H.R.; Raman, K.; McCall, J. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The Utility Bill Analysis of solar projects is discussed for a selected number of sites in the HUD Solar Program. The kinds of information that can be reliably obtained from the Utility Bill Analysis of solar projects and what are the limitations of this procedure are pointed out. How such an analysis may be supplemented and extended in order to make it an additional useful tool for the analysis of solar system performance are presented.

25727 (SERI/TP—245-430, pp 237-242) **Problems and questions in solar analysis methodology.** Sparkes, H.R.; Raman, K. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The evaluation of the solar projects in the HUD Solar Residential Demonstration Program has involved examining in detail a large variety of solar systems, and comparing the predicted thermal performance of these systems with the observed performance. Several questions and problems arise in the course of doing this, regarding the validity of some of the methods of solar analysis used, as well as the meaning of some of the concepts. These questions are discussed.

25728 (SERI/TP—245-430, pp 243-252) **Performance of the solar-assisted HVAC system for Terraset Elementary School with passive earth cover.** Whitelaw, R.L.; Michelsen, D.L.; McCulley, J.A. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Terraset Elementary School in Reston, Virginia, has now been in operation since February, 1977, serving 1000 children and faculty with a unique semi-underground construction, and floor plan totalling 69,000 sq. ft. on one floor. Its construction, and the performance modes and characteristics of its HVAC system are described by which it has achieved an annual energy consumption of 8.75 Btu/ft²-degree day, or $78.40 per ft² per 1000 degree days. A significant factor in this energy saving is the 36 in of passive earth cover on 10 in of reinforced concrete over the entire school, plus the surrounding 30° earth bank. The performance, and some deficiencies in the design of the passive earth cover are reported, along with various improvements proposed for the entire system.

25729 (SERI/TP—245-430, pp 253-273) **Cost effectiveness: an assessment based on commercial demonstration projects.** King, T.A.; Jefferson, Shingleton, J.G.; Sabatiuk, P.A.; Carlock, J.B. III. (Mueller Associates, Inc., Baltimore, MD). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Detailed after-the-fact construction costs are presented for 24 National Solar Demonstration projects. cost analyses include an evaluation of the cost components and cost factors impacting solar energy systems. Based on the results of these analyses and detailed performance data obtained from the National Solar Data Network, an economic assessment of nine operating systems is presented. The economic analyses include first year cost of energy, payback period, and rate of return. Implications for the cost effectiveness of similar systems in other areas and under different economic circumstances are investigated to the extent possible.

25730 (SERI/TP—245-430, pp 275-277) **Summary review: solar passive space heating systems.** Balcomb, J.D. (Los Alamos Scientific Lab., NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Evaluation criteria for the performance of the passive solar space heating of a building are listed. A few figures of merit for different passive solar buildings are tabulated. (MHR)

25731 (SERI/TP—245-430, pp 279-287) **Thermal performance of space cooling solar energy systems in the National Solar Data Network.** Bartlett, J.C.; Wallace, C.T. (IBM Corp., Huntsville, AL). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Results derived from analysis of data obtained from monitoring the operation of four solar energy cooling installations in the National Solar Network are presented. It is shown that chiller coeficients of performance (COP) on the order of 0.65 can be easily obtained with existing technology, provided the designer adequately matches the solar energy system to the absorption chiller. It is also shown that flat-plate, concentrating and evacuated tube collectors may each be used successfully to operate absorption chillers in space cooling systems. The results show that appreciation for the systems engineering aspects of solar energy is extremely important to the development of a viable industry.

25732 (SERI/TP—245-430, pp 289-295) **Solar heating and cooling results for the Los Alamos Study Center.** Hedstrom, J. C.; Murray, H.S.; Balcomb, J.D. (Los Alamos Scientific Lab., NM). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Solar energy system performance data for two heating seasons and two cooling seasons are given for the Los Alamos National Security and Resources Study Center, a 5576 m² (60,000 ft²) conference center and library at the Los Alamos Scientific Laboratory, New Mexico. The solar energy system for the Study Center consists of a 716 m² (7705 ft²) array of selectively coated, single-glazed collectors, a 19 m³ (5000 gal) pressurized tank for hot storage in the cooling mode, and a 38 m³ (10,000 gal) tank, which is used for hot storage in the heating mode and cold storage in the cooling mode. Either of two chillers may be used in series with the cold storage tank, a 1075 MJ (85 ton) absorption unit, or a 973 MJ (77 ton) Rankine cycle unit. Night evaporative cooling is also used to cool the large tank. A heat recovery unit is used to preheat fresh air in the winter, and, by means of spraying the exhaust air, to pre-cool fresh air in the summer. Daily, monthly, seasonal, and yearly energy summaries are presented for the system. Performance data for the two chillers include tabulation of thermal and system coefficients of performance. The solar fraction for the system was 69% for the 1978-79 heating season, which was down from 79% the previous winter. This was due to a more severe winter as the solar performance was about the same. The solar cooling fraction was 79% in 1978 versus 94% in 1979.

25733 (SERI/TP—245-430, pp 297-302) **Improving performance of solar cooling systems.** Ward, D.S.; Oberoi, H.S.; Grebe, J.M. (Colorado State Univ., Ft. Collins). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

During the summer of 1978, Colorado State University Solar House III utilized a Yazaki 2-ton lithium bromide absorption chiller, two 500 gallon cool storage tanks, one 1200 gallon hot storage tank (located within the conditioned space), 631 square feet of Chamberlain single single cover selective surface flat-plate solar collectors, and an electric auxiliary boiler. After a year of heating and cooling data were obtained, the system was redesigned in the spring of 1979. Major modifications included reduced piping runs, reduced electrical power requirements, elimination of cool storage, improved insulation, and a relocation of the hot storage to the exterior of the conditioned space. The performance results of these two distinct installations are shown. Also included are design predictions and selected data presentations which provide useful analysis of the variation in system performance. It is noteworthy that the solar collector array installation is the same for both system designs. The resulting values of those component and system parameters which are necessary for a realistic evaluation of any solar heating and cooling system are listed. An analysis of the two consecutive years of data acquisition on the two systems for selected months in the cooling season is included.

25734 (SERI/TP—245-430, pp 303-309) **Results of improvement in the decade 80 solar house cooling system.** Johnson, R.K.; Lyman, W.S. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The seasonal performance of the original and the improved versions of the Arkla solar-fired cooling system in the Decade 80 Solar House in Tucson, Arizona are compared. Data have been taken continuously on the performance of the system from October 1975 to the present. Data from the peak cooling months of July and August of 1976, 1977 and 1979 are compared. The air conditioning system was extensively modified during the summer of 1978 when two Arkla 501-WF direct expansion machines were replaced with two Arkla WF-36 water chillers. The lower operating temperature of the new units allowed the collector to collect up to 75% more energy. The lower temperatures yielded lower heat losses, as did reduced piping. Electric power consumption did not increase in spite of adding an additional pump. The fraction of the cooling provided by solar increased about threefold, and non-renewable fuel savings about sixfold.

25735 (SERI/TP—245-430, pp 311-316) **Performance of controllers in solar heating systems.** Kent, T.B. (Solar Control Corp., Boulder, CO); Winn, C.B. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Inspections of more than one hundred solar heating installations have been conducted by technical personnel from Solar Control Corporation and Solar Environmental Engineering Company, Inc. In addition, a survey of more than two hundred manufactures,

architects, engineers, solar system dealers and solar system installers has been performed by Solar Control Corporation for the purpose of determining perceptions regarding controllers. Results from the system inspections and the survey point to several problems in the area of controllers. These problems, the survey and results from the inspections are presented.

25736 (SERI/TP—245-430, pp 317-320) **Operational improvements in the CSU Solar House I system supplied with heat from evacuated collectors.** Duff, W.S.; Hancock, C.E.; Loef, G.O.G. (Colorado State Univ., Ft. Collins). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

During the months of May and June 1979, the CSU Solar House I operating system was completely repiped, rewired and reinstrumented, new pumps were installed, a new high-R-value modular heat storage tank with stratification enhancing manifolding was installed, and the system was modified so as to reduce pumping power and achieve improved performance. The new system became operational in mid-June and data have been recorded continuously since that time. Energy collection and utilization were increased by these design changes as well as by modified operating procedures. The location and extent of heat losses were determined by making progressive additions of insulation to system piping, heat exchangers and valves, and measuring the resulting changes in solar heat collection and use. The evacuated collector cover glass with 0.82 transmittance was replaced with a cover having solar transmittance of 0.91.

25737 (SERI/TP—245-430, pp 321-326) **Solar systems that work well.** Sparkes, H.R.; Raman, K. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

A great deal has been learned from the HUD Solar Program regarding problems and errors that occur in solar systems, either because of faulty design or because of defects in installation, operation and maintenance. The lessons learned can be used for determining what makes solar systems work well, and in suggesting designs and procedures for solar systems that will be free of the familiar defects. Selected solar systems are examined in the HUD Solar Residential Demonstration Program, to illustrate what makes solar systems work well.

25738 (SOLAR/0010—80/02) **Environmental data for sites in the National Solar Data Network.** (Automation Industries, Inc., Silver Spring, MD (USA). Vitro Labs. Div.). Feb 1980. Contract AC01-79CS30027. 221p. NTIS, PC A10/MF A01.

The network consists of (1) sensors which measure key performance parameters at a selected site; (2) a Site Data Acquisition System (SDAS); (3) telephone transmission circuits; and (4) a Central Data Processing System (CDPS). Sensor data are collected and stored on a cassette tape in the SDAS. The CDPS collects and processes the information at Vitro and performs the required computations. For the majority of parameters, raw data is collected approximately every five minutes. Solar insolation and certain other parameters, which are subject to rapid variance, are sampled every 32 seconds. The CDPS interrogates each SDAS on a daily basis and retrieves all accumulated data. At the conclusion of data retrieval, the SDAS Cassette is reset by command from the CDPS for continuing data collection. This report presents environmental information collected at the sites for the reporting month. Only those sites for which the data are found to be valid are reported.

25739 (SOLAR/1028—79/50) **Solar Project Description for Sir Galahad Company, single family residence, Virginia Beach, Virginia.** (Boeing Co., Seattle, WA (USA)). 20 Jul 1979. Contract EX-76-A-29-1020. 51p. NTIS, PC A04/MF A01.

The Sir Galahad Company solar energy system is installed in a single story, 1604 square-foot, conditioned area, three bedroom single family dwelling located in Virginia Beach, Virginia. The system is designed to provide solar energy for space heating, and domestic hot water heating. Solar energy is collected by an array of double glazed flat plate collectors with a gross area of 640 square feet. The collector array is mounted on the roof of the house and faces south at an angle of 45 degrees to the horizontal to optimize solar energy collection. Solar energy is transferred from the collector array to a 1500 gallon above ground storage tank. Water is used as the heat collection, transfer and storage medium. Freeze protection is provided by means of circulation of hot water from storage through the collectors. Anti-freeze additive is required. Space heating demands are met by circulating hot water from storage through air heating coils in an air distribution system located in the house. Auxiliary space heating is provided by a heat pump and electric heater strips. Solar energy for preheating domestic hot water is provided by circulating water from the solar storage tank through a water to water heat exchanger located solar storage tank. The dwelling has been fully instrumented for performance evaluation since October 1978 and the data is integrated into the National Solar Data Network. Original cost estimates for provisioning and installation of the solar system are given. However, the final solar system cost and the cost of its instrumentation are not included in this report.

25740 **Sensitivity of direct gain space heating performance to fundamental parameter variations.** Wray, W.O.; Balcomb, J.D. (Los Alamos Sci Lab, NM). *Sol. Energy;* 23: No. 5, 421-425(1979).

A computer program has been developed for analyzing the performance of direct gain passive solar heated enclosures. The computer program is validated by comparison with data from passive solar test cells at Los Alamos, New Mexico Solar Laboratory. The results of a sensitivity study involving variation of fundamental design parameters is presented. 7 refs.

25741 **Roof overhang design for solar control.** (Oak Ridge National Lab., TN). pp 153-157 of Proceedings of the fourth national passive solar conference. Barnes, P.R. Newark, DE; Univ. of Delaware (1979).

From 4. National passive solar conference; Kansas City, MO (3 Oct 1979).

Design formulas are developed for both fixed and extendable overhangs as a function of window height, geographic latitude and solar altitude. The extendable overhang is adjusted seasonally. Design parameters are suggested for near optimum solar control in direct-gain passive systems. A method of estimating the effect of an overhang on solar gain is also developed. Examples of the solar performance for both fixed and adjustable overhangs are presented for 36°N latitude.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 25616, 25639, 25798

25742 (SERI/TP—631-655) **Preliminary operational results of the industrial process heat field tests.** Kutscher, C.; Davenport, R. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4043. 6p. (CONF-800604—18). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

There are currently six DOE-funded solar industrial process heat (IPH) field tests which have been operational for one year or longer. These are all low temperature first generation projects which supply heat at temperatures below 100°C - three hot water and three hot air. During the 1979 calendar year, personnel from the Solar Energy Research Institute (SERI) visited all of these sites; the performance and cost results obtained for each project and the operational problems encountered at each site are discussed.

25743 (SERI/TP—731-626) **Use of solar energy to produce process heat for industry.** Brown, K. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 28p. (CONF-800373—1). NTIS, PC A03/MF A01.

From Plant engineering and maintenance conference; McCormick Place, Chicago, IL, USA (24 Mar 1980).

The role of solar energy in supplying heat and hot water to residential and commercial buildings is familiar. On the other hand, the role that solar energy may play in displacing imported energy supplies in the industrial and utility sectors often goes unrecognized. The versatility of solar technology lends itself well to applications in industry; particularly to the supplemental supply of process heat of all kinds. The realization of that potential will depend, however, on the identification of the most suitable applications and locations for industrial solar energy and the continued improvement in cost, durability, and reliability of solar equipment. The status of solar thermal technology for industrial process heat applications is surveyed, including a description of current costs and operating histories. Because the current status is unsatisfactory in view of the goals established by President Carter for solar industrial energy, the most important objectives to be met in improving system performance, reducing cost, and identifying markets for solar IPH are outlined. The effect of government tax policy will be of little impact until technical efficiency and cost effectiveness are significantly improved.

25744 **Solar enhanced oil recovery; an assessment of economic feasibility.** Bergeron, K.D. (Sandia Lab, Albuquerque, NM). *Energy (Oxford);* 4: No. 6, 1127-1137(Dec 1979).

There are several qualitative reasons why steam enhanced oil recovery (EOR) appears to be well suited to solar energy use. These include favorable characteristics with regard to energy utilization, land availability, energy form, and geographical location. A number of technical questions require further research before the characteristics of solar enhanced oil recovery (SEOR) can be precisely specified or optimum systems designed. However, a cost model based on a number of working assumptions indicates competitiveness with conventional fuel-burning EOR systems at crude prices and solar collector system costs which can be reasonably expected to occur in the near future; e.g., for a nominal parameter set, including a solar

energy system cost of $200/m², the breakeven crude oil price is $11.90/bbl. 15 refs.

WATER HEATING

REFER ALSO TO CITATION(S) 25668, 25697, 25701, 25707, 25715, 25720, 25739

25745 (DOE/NASA/CR—161434) **Solar hot water system installed at Quality Inn, Key West, Florida. Final report.** (Quality Inn of Key West, Miami Beach, FL (USA)). Apr 1980. Contract EG-77-G-01-1633; EX-76-A-29-1024. 25p. NTIS, PC A02/MF A01.

The solar energy hot water system installed in the Quality Inn, Key West, Florida, which consists of four buildings, is described. Three buildings are low-rise, two-story buildings containing 100 rooms. The fourth is a four-story building with 48 rooms. The solar system was designed to provide approximately 50% of the energy required for the domestic hot water system. The solar system consists of approximately 1400 ft² of flat plate collector, two 500 gal storage tanks, a circulating pump, and a controller. Operation of the system was begun in April 1978, and has continued to date with only three minor interruptions for pump repair. In the first year of operation, it was determined that the use of the solar facility resulted in 40% fuel savings.

25746 (SERI/TP—245-430, pp 7-12) **Thermal performance of DHW solar energy systems in the national solar data network during the 1978-1979 heating season.** Nash, J.M.; Cunningham, G.W. (International Business Machines, Gaithersburg, MD). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The thermal performance of nine solar energy systems designed to provide heating for domestic hot water (DHW) for the period October 1978 through March 1979 is summarized. The systems were selected as representative of DHW heating systems being monitored by the National Solar Data Network. Three general types of DHW heating systems are included in this presentation. These types are described as systems providing only DHW heating, systems providing DHW and space heating without a recirculation loop between the main solar storage and the DHW subsystem, and systems providing DHW and space heating with a recirculation loop. For the period reported, the average DHW solar coefficient of performance (COP) varied significantly for each system type. Further variance of COP was observed within system type as a function of single vs. multiple DHW tank design. Discussion of the significance of this variation and other thermal performance parameters is presented for each of the nine systems.

25747 (SERI/TP—245-430, pp 13-17) **Performance of a daystar HW2/F-B solar water heater in southern New Jersey.** Taylor, H.E. (Stockton State College, Pomona, NJ). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

A Daystar HW2/F-B solar water heater installed (39.5°N latitude) in October, 1977 has been continuously monitored by microcomputer controlled instrumentation since January 1, 1979. During the first 7 months (Jan-July 1979) average daily measurements were as follows: Useful heat - 13,800 kJ/day (3.83 kW-hr/day); Insolation - 13,900 kJ/M²/day (3.86 kW-hr/M²/day); Solar system electrical usage - 2328 kJ/day (0.65 kW-hr/day); Hot Water Usage - 173 l/day (45.6 gal/day) and backup electrical heat 10,100 kJ/day (2.82 kW-hr/day). The system consists of 3.92M² (42.2 ft²) net area of Daystar type 21-B collectors facing due south and tilted 45° from the horizontal, together with a single 80 gallon tank for storage. The microcomputer monitors 6 temperatures, the integrated insolation and on/off time for both the collector loop circulator and the backup electric heat once each minute. It then calculates 10-minute averages, and one hour average water usage figures are taken manually each day.

25748 (SERI/TP—245-430, pp 19-24) **Thermal performance of a solar heated hot water system.** Rockeffer, H.A.; Tipton, J.A. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The thermal performance analysis of the 54.3 m² (585 ft.²) flatplate solar collector hot water heating system at the Bartlesville Energy Technology Center found the system had an extremely low summertime efficiency due to light hot wate heating requirements. The collector efficiency increased from 25% in July to 41% in October due to the greater hot water heating requirements. The increase in required heat was caused by a modification to route the domestic hot water return through the solar storage tank as well as a demand increase due to the change in seasons from summer to fall. The average daily savings in nonrewable energy resources also increased from 2500 kJ/day (2400 Btu/day) to 74,000 kJ/day (71,000 Btu/day) during the same period of time. Instrumentation used in the analysis included several thermometers, two American Meter Btu meters, and an Eppley 8-48 pyranometer.

25749 (SERI/TP—245-430, pp 25-31) **Performance of six solar domestic hot water systems in the mid-atlantic region.** Fanney, A.H.; Liu, S.T. (National Bureau of Standards, Washington, DC). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

In order to provide data required for the validation of computer programs for solar domestic hot water systems, the staff of the National Bureau of Standards (NBS) fabricated and instrumented six typical residential-size systems at tits Gaithersburg, Maryland site. Three of the six systems utilize a single hot water tank and the other three utilize two tanks. Three different methods of freeze protection are being utilized among the systems: water-ethylene glycol mixture in the collector loop with an intermediate heat exchanger, drain-down using solenoid valves to dump the water from the collectors, and air-heating collectors in conjunction with an air-water heat exchanger. One system relies on the thermosyphon principle while the other five require electric power for fans or pumps. The systems have been operating since June, 1978. The testing done is described and the experimental results are given for the first year of operation.

25750 (SERI/TP—245-430, pp 33-38) **Interim performance results from the Northeast States' Solar Water Heater Performance Monitoring Program.** Erhartic, P. (Northeast Solar Energy Center, Cambridge, MA). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The results of the Northeast States Solar Water Heater Performance Monitoring Program will be of tremendous value to the solar industry, solar-oriented government agencies and the general public. They will establish the state of the technology of Northeast solar water heating from 1978 through 1980 and assess the general effects of HUD Initiative approval, program warranty requirements, installer training and solar industry maturation on the quality of the installed products. The program will also assess the application of low-cost systems for the monitoring of solar water heater performance. The 200 sites chosen for this program consist of solar water heaters installed under the United States Department of Housing and Urban Development (HUD) Solar Hot Water Initiative. At the present time (10/1/79), 90 sites have been monitored and 510 months of operational data have been collected. The performance results from 166 months of monitoring data are presented with performance intervals ranging from three to twelve months. A description of the monitoring technique is included with a discussion about water heating system losses and data validation.

25751 (SERI/TP—245-430, pp 39-44) **Preliminary results: solar domestic hot water monitoring in Pennsylvania.** Aungst, W.K. (Pennsylvania State Univ. Middletown). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The Pennsylvania State University, acting for the Northeast Solar Energy Center, is aiding in a monitoring program for fifty solar domestic hot water systems in Pennsylvania. Each of the monitored sites was the recipient of a $400 HUD grant as part of HUD's Solar Hot Water Initiative Project. The monitoring program utilizes relatively low cost instrumentation, which provides information which is collected by each individual home-owner. This data is collected by PSU and the performance of each system is determined using computers at PSU. Feedback in the form of a summary of the results of the computer analysis is provided to each homeowner approximately every four months. The average solar contribution toward the energy required for the domestic hot water is approximately 34% for all the sites evaluated to date. The best ten sites are averaging approximately 44%.

25752 (SERI/TP—245-430, pp 45-50) **Performance data on solar-assisted hot-water systems in five Tucson residences.** Kinney, R.B.; Vassmer, G.R. (Univ. of Arizona, Tucson). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The performance of five residential hot-water systems has been monitored since early January 1979. Two conventional systems have also been studied for comparative purposes. All homes are in the same housing development and are occupied by private individuals. Hot-water and electric-power consumption are measured at weekly intervals. From an analysis of the data, the fraction of required energy supplied by the insolation is determined. Solar energy incident on the collectors is calculated using measurements made locally for a horizontal surface. The fraction of energy supplied by solar was found to vary from approximately 60% in January to 97% in July, although one house had values above 90% for the entire period. Representative system efficiencies were calculated wherever possible. This varied greatly over the weeks and months and was found to be strongly dependent on the family size and water-use patterns.

25753 (SERI/TP—245-430, pp 51-56) **Design and operation of solar DHW systems.** Ostrye, N.B. (General Development and Supply, Deatsville, AL). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The design, installation and performance of three different types of solar domestic hot water systems are discussed. The first system is one which uses silicone oil as the heat transfer fluid. This was an early system which did not work well. Problem areas such as entrapped air, leaks, poor soldering techniques, stagnation, and the low specific heat of the silicone oil are all covered as well as the poor overall performance of the tube on shell type heat exchanger. A readily available prepackaged dual wall tank system using a 50% Prestone II and 50% water solution is shown. Installation of additional insulation and the value of a water heater timer is discussed with emphasis on the savings of fossil fuel. Actual performance fulfilling the hot water needs of a family of three during a 30-day period is shown. A unique, simplified drain back system where the drain back tank is used as an expansion tank as well as reservoir is shown; its performance fulfilling the needs of a family of four over a 30-day period is also shown.

25754 (SERI/TP—245-430, pp 57-60) **System description and early performance of pool and domestic water heating installation, Willmar State Hospital, Willmar, Minnesota.** Cummings, P.F. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

The Willmar State Hospital, located in Willmar, Minnesota, August 1979 placed into service a new building, designed to provide physical and therapeutic treatment for mentally retarded, mentally ill, and chemically dependent patients. A solar collector system provides heating of swimming pool water, heating of domenstic water, and tempering of ventilation air to the swimming pool area. The installation consists of appromimately 3,000 square feet of flat-plate solar energy collectors, roof-mounted, which are designed to collect 54,000 MBTU during June and 22,000 MBTU during December. The primary heat exchange fluid is ethylene glycol and water which is pumped through heat exchangers for use or storage. The instrumentation installed to measure performance of the solar system and the information collected in the initial operations are described. The cost of the building, on which bids were received in July, 1977 was $2,000,000, including fees; and for the solar system, on which bids were received in June, 1978, was $205,000, including fees. The primary purpose of the solar installation data applicable to other potential solar projects of the Minnesota state government.

25755 (SERI/TP—245-430, pp 69-76) **Performance of a solar hot water system installed in an interstate highway visitor center: results of one year of monitoring.** Jackson, D.R. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

At one of the visitor centers, located in Willington, Connecticut on Interstate 86 Eastbound, a solar hot water system has been installed and has been operating since early July, 1978. The system is heavily instrumented and is being monitored by a 24 channel magnetic tape data logger with a one minute sampling rate. The rapid sampling rate of the data acquisition system provides an extremely detailed picture of the operation of the system under this widely fluctuating hot water demand, and ultimately insight into the effectiveness and economics of solar energy in this application. Since becoming operational in July 1978 very little trouble has been encountered with solar system operation (excluding the data system which has experienced (excluding the data system which has experienced some down time). Performance predictions using the F-Chart method have produced sizeable deviations from actual performance in individual months, all of which fall below actual measured monthly values. Performance data for the full one year period from September 1, 1978 to August 31, 1979 are presented. Monthly summaries of all important energy flows are presented. Incident solar radiation will be traced through the system and the various losses accounted for. Insolation data hourly and daily water use characteristics for the facility are also presented.

25756 (SERI/TP—245-430, pp 77-84) **Solar water heater demonstration.** Guinn, G.R.; Novell, B.J. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

A demonstration of six commercially available solar water heaters has been erected by the Alabama Solar Energy Center for the purpose of developing public awareness of commercialized technology and acquiring factual performance and operational data. The six systems are installed side-by-side on a typical roof structure and provide two examples each of silicone oil, antifreeze and drain-back freeze protection. Each system is instrumented with BTU and KWH meters to assess performance under an imposed F-CHART load profile. The systems under evaluation, the instrumentation and results acquired over a recent three week period are described.

25757 (SERI/TP—632-635) **Analysis of solar domestic hot water systems from a system perspective.** Murphy, L.M.; Farrington, R.; Noreen, D. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 8p. (CONF-800604—10). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Six solar domestic hot water systems tested at the National Bureau of Standards have been analyzed. Results indicate that the thermosyphon system delivered the most solar energy to the load per dollar of initial investment (the air system delivered the least) and that direct systems performed better than indirect systems. Storage losses from the double tank systems were greater than expected, and this significantly reduced the relative performance of these systems. Further, the use of pumps, fans, controls, and solenoid valves in the pumped systems can reduce the net energy savings of the solar system by up to 30%.

25758 **Is solar really the best way?.** Hirst, E. (Oak Ridge Natl Lab, Ill). *ASHRAE J.;* **22**: No. 1, 60-62(Jan 1980).

This article examines the potential energy and economic benefits of three different residential water heating systems: conventional, dedicated heat pump, and solar. Results show that no one system can provide optimal efficiency for every geographic region in the continental U.S.

OTHER

REFER ALSO TO CITATION(S) 25451

25759 (EUR—6748-EN) **Absorption refrigeration machine driven by solar heat. Final report.** Keizer, C.; Liem, S.H. (Technische Hogeschool Delft (Netherlands)). 1980. 101p. NTIS (US Sales Only), PC A06/MF A01.

A mathematical model of a Single and a Two Stage Solar Absorption Refrigeration System is developed, in which data of collectors and weather data can be implicated. The influence of the generator and the absorber efficiencies and the cooling temperature on the characterisitcs of COP of a Single and Two Stage Absorption Refrigeration Process are investigated and the minimum evaporator temperatures for certain cooling and heating temperatures and the working range of a single and two stage absorption refrigeration machine are determined. For low generator temperatures the absorber efficiency has more influence on COP than the generator efficiency. Only spectral selective double window and high performance collectors can be used for air cooled solar absorption refrigeration systems at an evaporator temperature of -5°C. The other types collectors cannot reach the required high heating temperatures. It can be concluded that a water cooled solar absorption refrigeration system in combination with a solar tapwater installation for household use can be achieved with 6 to 8 m^2 high performance collector area. (MHR)

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 25563, 25610, 25617, 25619, 25620, 25621, 25622, 25675, 25705, 26465

25760 **Radiant energy collection and conversion apparatus and method.** Hunt, A.J. US Patent Application 061,165. [nd]. 26p.

The apparatus for collecting radiant energy and converting to alternate energy forms includes a housing having an interior space and a radiation transparent window allowing solar radiation to be received in the interior space of the housing. Means are provided for passing a stream of fluid past the window and for injecting radiation absorbent particles in said fluid stream. The particles absorb the radiation and because of their very large surface area, quickly release the heat to the surrounding fluid stream. The fluid stream particle mixture is heated until the particles vaporize. The fluid stream is then allowed to expand in, for example, a gas turbine to produce mechanical energy. In an aspect of the present invention properly sized particles need not be vaporized prior to the entrance of the fluid stream into the turbine, as the particles will not damage the turbine blades. In yet another aspect of the invention, conventional fuel injectors are provided to inject fuel into the fluid stream to maintain the proper temperature and pressure of the fluid stream should the source of radiant energy be interrupted. In yet another aspect of the invention, an apparatus is provided which includes means for providing a hot fluid stream having hot particles disbursed therein which can radiate energy, means for providing a cooler fluid stream having cooler particles disbursed therein, which particles can absorb radiant energy and means for passing the hot fluid stream adjacent the cooler fluid stream to warm the cooler fluid and cooler particles by the radiation from the hot fluid and hot particles.

25761 (ALO—4123-5) **Development of a site-fabricated, building integrated air solar system. Final report, September 30, 1977-April 30, 1980.** Temple, P.L.; Kohler, J.T. (Total Environmental Action, Inc.,

Harrisville, NH (USA)). Apr 1980. Contract FG04-77CS34123. 164p. NTIS, PC A08/MF A01.

The results of a two year project to develop, thoroughly test, and optimize a complete site-fabricated solar air heating system are presented. The project has produced the only site-fabricated air collector at this time to be fully tested to ASHRAE 93-77 standards and the HUD 30-day stagnation test; it is found that the collector performs as well as any standard commercially manufactured air collector, but for only one-third the cost. The initial stage of the project consisted of a detailed survey of existing site-built installations throughout the country, the generation of innovative designs, the selection of the six best designs, a thorough analysis of these, and the choice of the best design for further work. The chosen design then underwent extensive development. A central part of the project was the study of all the available collector materials: glazings, paints, coatings, caulks, absorber plates, structural materials, and fasteners. With the results of the materials study, the collector design was further optimized in terms of theoretical efficiency, ease of construction, appearance, and durability. The result of the entire project is a tested, proven design, and with more than 15 fully operating systems in buildings throughout the Northeast, including both retrofit and new construction. The final product is detailed construction manual with step-by-step instructions, complete construction drawings, and background information on materials and design options. (MHR)

25762 (ALO—5364-T1) **Wind effects on collectors. Final report, October 1, 1978-October 1, 1979.** Hewitt, H.C. Jr.; Griggs, E.I. (Tennessee Technological Univ., Cookeville (USA). Dept. of Mechanical Engineering). 1 Nov 1979. Contract EM-78-C-04-5364. 109p. NTIS, PC A06/MF A01.

Separate abstracts were prepared for each of the four chapters. (MHR)

25763 (ALO—5364-T1, pp 2-18) **Correlating existing meteorological data to predict local conditions.** 1 Nov 1979.

In Wind effects on collectors. Final report, October 1, 1978-October 1, 1979.

Consideration was given to modeling wind speed data and to a scheme for correlating data between two separate stations. It was concluded that speed data can be represented adequately by one of the probability models such as the chi^2-distribution. Attempts to find meaningful correlation of speed and direction data between two separate stations were at best inconclusive. Experimental data were also collected and compared. Generally, the directional behavior of wind near roofs did not correlate well even with data corresponding to nearby measurements in an unobstructed area. Speed data, on the other hand, did correlate fairly well. The results of the study suggest possibilities for exploring the modeling in more detail. Extensive regional assessments of daytime data should be made to serve as input for statistical evauation of wind speed effect on collector performance.

25764 (ALO—5364-T1, pp 19-27) **Supplementary meteorological data collection.** 1 Nov 1979.

In Wind effects on collectors. Final report, October 1, 1978-October 1, 1979.

A sensor system was developed to measure the effect of wind on collector performance. The specifications for the sensor are presented, and a discussion of the calibration of the sensor is given. The sensor can be used to measure the convective film heat transfer coefficient under steady conditions. However, it is recommended that a continuous effort be made to establish a statistical data base for use in predicting the effect of wind on collector performance.

25765 (ALO—5364-T1, pp 28-58) **Experimental air flow patterns over buildings.** 1 Nov 1979.

In Wind effects on collectors. Final report, October 1, 1978-October 1, 1979.

Four experiments were performed to determine wind flow patterns around buildings. The velocity profiles were measured around model houses in a wind tunnel. The introduction of simple obstructions was used to evaluate their effect on flow over the roof of a house. The results of this study are presented along with measurements which determined the effect of these flow patterns on the resulting heat transfer coefficient. The velocity profile over an actual collector was also measured as a function of free stream velocity. This was limited to the single case and concerned the region of separation at the leading edge of the collector. A water table experiment was also performed to give flow visualization around model buildings. The model was shown to provide a rapid evaluation of the influence of simple upstream obstructions on velocity profiles.

25766 (ALO—5364-T1, pp 59-109) **Experimental heat transfer on collectors.** 1 Nov 1979.

In Wind effects on collectors. Final report, October 1, 1978-October 1, 1979.

A mathematical model for a solar collector and three experimental efforts to measure the effect of wind on collector performance are reported. A fundamental study on heat transfer over a flat-plate revealed that the heat transfer was less than previous works found. It also gave some data for flow from a direction behind the plate. The results indicate that wind from the northern quadrants may not affect collector performance. Flow over actual collectors was used to determine the effect of wind on collector performance. Air- and liquid-cooled collectors were tested. The experimental study on collectors in an outdoor environment was complemented by some indoor tests on small-scale collectors using artificial lighting as the energy source. Both liquid-cooled and air-cooled collectors were tested. The percent reduction in useful energy collection was seen to depend on wind speed, but it was also seen to vary with the difference between the average internal fluid temperature and the environmental temperature. The results appeared to corroborate those observed in the outdoor tests.

25767 (COO—4094-66) **Analytical prediction of liquid photovoltaic/thermal flat-plate collector performance.** Raghuraman, P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 29 Nov 1979. Contract EY-76-C-02-4094. 19p. NTIS, PC A02/MF A01.

A one-dimensional analysis has been developed that predicts the electrical and thermal efficiencies of a liquid photovoltaic/thermal flat-plate collector - the latter, to within 4 percent. The analysis, agreeing with test measurements, reduces the 15-percent difference between analysis and measured thermal efficiency obtained by the classical analysis of Hottel and Whillier as extended by Florschuetz to PV/T collectors.

25768 (DOE/CS/34196—T1) **Dual curvature acoustically damped concentrating collector. Final technical report.** Smith, G.A.; Rausch, R.A. (Honeywell, Inc., Minneapolis, MN (USA). Technology Strategy Center). May 1980. Contract EM-78-C-04-4196. 348p. NTIS, PC A15/MF A01.

A development program was conducted to investigate the design and performance parameters of a novel, dual curvature, concentrating solar collector. The reflector of the solar collector is achieved with a stretched-film reflective surface that approximates a hyperbolic paraboloid and is capable of line-focusing at concentration ratios ranging from 10 to 20X. A prototype collector was designed based on analytical and experimental component trade-off activities as well as economic analyses of solar thermal heating and cooling systems incorporating this type of collector. A prototype collector incorporating six 0.66 x 1.22 m (2 x 4 ft) was fabricated and subjected to a limited thermal efficiency test program. A peak efficiency of 36% at 121°C (250°F) was achieved based upon the gross aperture area. Commercialization activities were conducted, including estimated production costs of \$134.44/m^2 (\$12.49/ft^2) for the collector assembly (including a local suntracker and controls) and \$24.33/m^2 (\$2.26/ft^2) for the reflector subassembly.

25769 (DOE/CS/35303—T1) **Development of 400°F sealants for flat plate solar collector construction and installation. Final report, 1 October 1978-30 September 1979.** Morris, L.; Schubert, R.J. (Products Research and Chemical Corp., Glendale, CA (USA)). Mar 1980. Contract AC04-78CS35303. 71p. NTIS, PC A04/MF A01.

Twenty candidate sealants representing ten different polymer types were evaluated as potential solar collector sealants. Polymer types tested included epichlorohydrin rubber, EPDM rubber, silicone, polysulfide, acrylate rubber, and a fluoroelastomer. Initial screening of sealants consisted of measuring high temperature stability and adhesion retention. Several sealant compositions exhibited satisfactory performance in these tests and were selected for further evaluation. These materials were based on an EPDM rubber, a Viton fluoroelastomer, and silicone polymers. Further testing of these candidate materials included determination of adhesion retention under uv/water/heat conditions, fogging temperature, low temperature flexibility, and physical properties. Four silicone-based materials appeared to be suitable candidates for sealing solar collectors. These include Dow Corning 90-006-02 and 3120, General Electric 1200, and PR-1939 from Products Research and Chemical Corporation.

25770 (DOE/JPL—1012-41) **Proposed method for determining the thickness of glass in solar collector panels.** Moore, D.M. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Mar 1980. Contract EX-76-A-29-1012. 76p. NTIS, PC A05/MF A01.

An analytical method has been developed for determining the minimum thickness for simply supported, rectangular glass plates subjected to uniform normal pressure environmental loads such as wind, earthquake, snow, and deadweight. The method consists of comparing an analytical prediction of the stress in the glass panel to a glass breakage stress determined from fracture mechanics considerations. Based on extensive analysis using the nonlinear finite element structural analysis program ARGUS, design curves for the structural analysis of simply supported rectangular plates have been developed. These curves yield the center deflection, center stress and corner stress as a function of a dimensionless parameter describing the load intensity. Results are included for plates having length-to-width ratios of 1, 1.5, 2, 3, and 4. The load range considered extends to 1000 times the load at which the behavior of the plate becomes

significantly nonlinear. Over the load range analyzed, the analysis shows that the ratio of center deflection to plate thickness for a plate of length-to-width ratio of 4 is less than 70 to 1, whereas linear theory would predict a center deflection about 1200 times the plate thickness. The stress is also markedly lower than would be predicted by linear theory. These analytical results show good agreement with the analytical and experimental work of others.

25771 (DOE/JPL—1060-33, pp 5-17) **Overview of Distributed Receiver Program.** Rannels, J.E. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

As we enter the 80's, a transition from solar thermal research and development to deployment of hardware in user environments is occurring. The early stages of a commercial structure are beginning to emerge, and, as we move towards the cost goals of 1990, solar thermal systems demonstrate great potential for relieving much of the energy burden in the US. A brief description of how we arrived where we are, and where we're going in distributed receiver solar thermal technology development is given.

25772 (DOE/JPL—1060-33, pp 19-26) **Heat and electricity from the sun using parabolic dish collector systems.** Truscello, V.C.; Williams, A.N. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

This paper addresses point focus distributed receiver (PFDR) solar thermal technology for the production of electric power and of industrial process heat, and describes this thermal power systems project conducted by JPL under DOE sponsorship. Project emphasis is on the development of cost-effective systems which will accelerate the commercialization and industrialization of plants up to 10 MWe, using parabolic dish collectors. The characteristics of PFDR systems and the cost targets for major subsystems hardware are identified. Markets for this technology and their size are identified, and expected levelized bus bar energy costs as a function of yearly production level are presented. Finally, the present status of the technology development effort is discussed.

25773 (DOE/JPL—1060-33, pp 27-33) **Line-Focus Concentrating Collector Program.** Dugan, V.L. (Sandia National Labs., Albuquerque, NM). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The Line-Focus Concentrating Collector Program has been in effect since about 1973. This program has emphasized the development and dissemination of concentrating solar technology in which the reflected sunlight is focused onto a linear or line receiver. Although a number of different types of line-focus concentrators have been developed, the parabolic trough seems to have gained the widest acceptance and utilization within the industrial and applications sectors. The trough is best applied for application scenarios which require temperatures between 140° and 600°F. Another concept, the bowl, is being investigated for applications which may require temperatures in the range between 600° and 1200°F. Current technology emphases are upon the reduction of system installation cost and the implementation of production oriented engineering.

25774 (DOE/JPL—1060-33, pp 35-39) **Test Bed Concentrator (TBC).** Goldberg, V.R. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A point focussing concentrator design was adapted from an existing communications antenna for use in a solar test bed application. The structure design, configured for use with JPL's spherical radius mirror panels, made no attempt toward optimization. The key objectives of stiffness, pointing accuracy, and timely delivery were exceeded. The system weight is approximately 16,000 Kg (36,000 lbs) and has a calculated 1 sigma system error of 0.03 degrees. The completed installation of two concentrators was accepted one month ahead of schedule.

25775 (DOE/JPL—1060-33, pp 41-46) **Test Bed Concentrator mirrors.** Argoud, M.J. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The Test Bed Concentrator (TBC) was designed to test components of point-focusing distributed receiver (PFDR) systems. The reflective surface of the concentrator was fabricated using mirror-facet designs and techniques previously developed at JPL. The facets are made by bonding mirrored glass to spherically-contoured substrates. Several aspects of the earlier work were reevaluated for application to the TBC: optimum glass block size, material selection, environmental test, optical characteristics, and reliability. A detailed explanation of tooling, substrate preparation, testing techniques, and mirror assembly is presented.

25776 (DOE/JPL—1060-33, pp 47-51) **Initial test bed concentrator characterization.** Starkey, D.J. (Jet Propulsion Lab., Pasadena, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

This paper reports on the operational characterization of the Test Bed Concentrator (TBC). The control system responsible for tracking and safe operation of the TBC is discussed in detail. The techniques used for mirror alignment and verification are also described. The plans for future tests using the TBC are reviewed.

25777 (DOE/JPL—1060-33, pp 53-57) **OMNIUM-G HTC-25 Tracking Concentrator.** Zelinger, S. (OMNIUM-G, Anaheim, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

On May 3, 1978, OMNIUM-G installed its first point focusing, two axis-tracking, high concentration ratio parabolic reflector. since then, OMNIUM-G has delivered and installed thirteen additional concentrators throughout the world. As a result of these initial installations, field data has been plentiful and the data has given OMNIUM-G the ability to invoke design refinements in several areas. The improvements have manifested in a design that is economic in the areas of manufacturing, packaging, delivering, installing, and commissioning the system into operation. OMNIUM-G's unique field experience coupled with engineering improvements is paving the way for long life, highly reliable, and economic fields of point focused distributed receiver solar thermal power systems. This paper deals specifically with OMNIUM-G's model HTC-25 Tracking Concentrator, the initial problems and their subsequent solutions. The HTC-25 Tracking Concentrator has found applications in educational institutions because of its ability to operate at extremely high focal point temperatures in excess of 4000°F. When the HTC-25 is operated as the nucleus of a solar thermal power sytem, the ability to operate water-to-steam converters at 1100°F and air converters at temperatures of 1800°F has opened the door to applications as electrical power generation, enhanced oil recovery, and water purification and desalination to the extent that these applications may be served more economically than from any other means of solar thermal technology.

25778 (DOE/JPL—1060-33, pp 59-61) **Shenandoah concentrator.** Poche, A.J. (General Electric Co., King of Prussia, PA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A 7-meter diameter, parabolic dish solar collector has been designed and developed for first application at Shenandoah, Georgia by the US Department of Energy Solar Total Energy Project. Key features and requirements for the collector are outlined. Performance test results for collector testing at Sandia Laboratories in Albuquerque are summarized. The key features, requirements and performance of the solar collector subassemblies/subsystems are discussed: mount and drives, reflector, receiver and collector control unit. Problems experienced during collector testing in Albuquerque are identified and solutions described.

25779 (DOE/JPL—1060-33, pp 63-67) **First generation low cost point focus solar concentrator.** Zimmerman, J. (General Electric Co., Valley Forge, PA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The General Electric Company is under contract to the Jet Propulsion Laboratory to design, fabricate, install and test a point focus solar concentrator that, given a high volume of production, will optimize the ratio of performance to cost. The concentrator design approach has evolved by a systematic process of examining the operating requirements particular to the solar application, minimizing material content through detail structural design and structurally efficient subsystem features, and utilizing materials and processes compatible with high volume production techniques. This paper briefly describes the design approach, the rationale for the configuration and subsystem selections, and the development status.

25780 (DOE/JPL—1060-33, pp 69-73) **Cellular glass substrate solar concentrator.** Bedard, R.; Bell, D. (Acurex Corp., Mountain View, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

Acurex Corporation, under contract to the Jet Propulsion Laboratory, is developing a second generation point focusing solar concentrator. The design is based on reflective gores fabricated of thin glass mirror bonded continuously to a contoured substrate of cellular glass. To date the preliminary design effort is complete and is reviewed in this presentation. The concentrator aperture and structural stiffness has been optimized for minimum concentrator cost given the performance requirement of delivering 56 kW/sub th/ to a 22 cm (8.7 in) diameter receiver aperture with a direct normal insolation of 845 watts/m² and an operating wind of 50 kmph (31

mph). The reflective panel, support structure, drives, foundation and instrumentation and control subsystem designs, optimized for minimum cost, are summarized. The use of cellular glass as a reflective panel substrate material is shown to offer significant weight and cost advantages compared to existing technology materials. Lastly, a design summary and key results are presented.

25781 (DOE/JPL—1060-33, pp 95-98) **Non-Heat Pipe/P-40 Stirling Engine.** Haglund, R.A. (Fairchild Stratos Div., Manhattan Beach, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

This project will demonstrate the technology for a full-up Hybrid Point-Focus Distributed Dish Stirling Solar Thermal Power system by the fall of 1980 at JPL's Desert Solar Test Facility near Lancaster, California. Hybrid operation is provided by fossil fuel combustion augmentation, which enables the Stirling engine to operate continuously at constant speed and power, regardless of insolation level, thus providing the capability to operate on cloudy days and at night. The Non-Heat-Pipe Receiver/P-40 Stirling Engine system will be installed and operated on the JPL Test Bed Concentrator. A 25-kW direct-driven induction-type alternator will be mounted directly to the P-40 engine to produce to a 60-Hz, 115/230-volt output.

25782 (DOE/JPL—1060-33, pp 119-123) **JPL's Parabolic Dish Test Site.** Hagen, T.L. (Jet Propulsion Lab., Pasadena, CA). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A Parabolic Dish Test Site (PDTS) has been established at the Jet Propulsion Laboratory (JPL) California Institute of Technology's Edwards Test Station (ETS) in the California Mojave Desert to carry out Department of Energy (DOE) sponsored work in testing solar point focusing concentrator systems and related hardware. The site was chosen because of its high solar insolation level and year around clear sky conditions. A description of the Parabolic Dish Test Site objectives and capabilities is contained herein. Also described are the various facilities and equipment at the PDTS, and the concentrator experiments being performed.

25783 (DOE/JPL—1060-33, pp 125-131) **OMNIUM-G concentrator test results.** Patzold, J.D. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The Jet Propulsion Laboratory Solar Thermal Power Systems Project, Module Development, conducted a performance evaluation on a commercially available point-focus solar concentrator manufactured by the Omnium-G Company. Thermal power test results indicate that slightly more than six kilowatts of thermal energy is available from a system of this configuration using a 10 cm aperture under the conditions outlined.

25784 (DOE/JPL—1060-33, pp 133-137) **JPL flux mapper.** Owen, W.A. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The JPL Flux Mapper is a device that can map the intensity distribution in three dimensions of concentrated solar energy at the focus of a concentrator. Intensities to 10,000 solar constants can be measured. Constructed to assist in concentrator and receiver development, it consists of a radiometer which is moved through the concentrated sunlight in a series of planes perpendicular to the optical axis by means of a mechanical rastering device. Various radiometer probes can be utilized depending on the time and accuracy requirements of the program. Energy levels are recorded as a function of location. Reduction of this data can be in various formats, e.g., contour maps, digital arrays, isometric visualizations and other displays as the user requires.

25785 (DOE/JPL—1060-33, pp 139-144) **Costing the Omnium-G System 7500.** Fortgang, H.R. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

A complete Omnium-G System 7500 was cost analyzed for annual production quantities ranging from 25 to 100,000 units per year. Parts and components were subjected to in-depth scrutiny to determine optimum manufacturing processes, coupled with make or buy decisions on materials and small parts. When production quantities increase - both labor and material costs reduce substantially. A redesign of the system that was analyzed could result in lower costs when annual production runs approach 100,000 units/year.

25786 (DOE/JPL—1060-33, pp 145-152) **TBC costing.** Kaminski, H.L. (Pioneer Engineering and Manufacturing Co., Warren, MI). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The primary task under this contract is to determine the cost of producing and installing a Parabolic Dish Concentrator in annual production volumes of 10,000, 50,000, 100,000 and 1,000,000 units. Each individual part will be evaluated for material cost, the type and number of operations required to work the raw material into the finished part. Each operation will be costed for labor, burden, tooling, gaging, machinery and equipment. Facilities requirements will be estimated for each production volume. Suggestions will be made for design and material alterations that could result in cost reduction.

25787 (DOE/JPL—1060-33, pp 217-220) **Crosbyton project.** Reichert, J.D. (Texas Tech. Univ., Lubbock). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The occasion of this meeting was a Big Event for the Crosbyton Solar Power Project. The project both hosted the meeting and used the occasion for the first test of the ADVS, the largest single solar collector ever built. This project represents the only American work on the Bowl Concept, which Texas Tech refers to as the Solar Gridiron Concept. The concept is unique among the concentrating/tracking concepts in that it employs a stationary mirror to reduce cost. Tracking is accomplished by moving the receiver/boiler. The ADVS gridiron mirror forms a 120° arc of a sphere, surfaced with 430 curved panels, each about 1 m x 1 m. The aperture diameter of the dish is 65-ft. The preliminary system performance agrees with the predictions and expectations. The mission of the project is to determine the feasibility and utility of building a 5 MWe solar-fossil fuel hybrid electric power plant employing the Solar Gridiron Concept, and, should the technical basis warrant construction, then to establish such a power plant at Crosbyton, Texas.

25788 (DOE/NASA/CR—161421) **Comparison of indoor-outdoor thermal performance for the Sunpak evacuated tube liquid collector.** (Wyle Labs., Huntsville, AL (USA). Solar Energy Systems Div.). Mar 1980. Contract EX-76-A-29-1037. 47p. NTIS, PC A03/MF A01.

Performance data is provided for current Sunpak production collectors. The effects of an improved manifold are seen from the test results. The test results show excellent correlation between the solar simulator derived test results and outdoor test results. Also, because of different incident angle modifiers, the all-day efficiency of this collector with a diffuse reflector is found to be comparable to the performance with the standard shaped specular reflector.

25789 (LBL—10100) **Performance analysis of a windowed high temperature gas receiver using a suspension of ultrafine carbon particles as the absorber.** Fisk, W.J.; Wroblewski, D.E. Jr.; Hunt, A.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 8p. (CONF-800604—23). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The results of an analytical study of the efficiency of single and double-windowed high temperature solar receivers suitable for use with small central tower or point focus dish collectors are summarized. A detailed window energy balance is used to predict the window temperature. The receiver energy losses, receiver efficiency, and associated thermodynamic cycle efficiency are calculated. The efficiencies for the base line design for single and double-windowed receivers are 93.8% and 95.4% respectively. A sensitivity analysis is used to determine the effects of varying the temperature, concentration ratio, and glass reflectivity.

25790 (LBL—10293) **Metallurgical analysis and high temperature degradation of the black chrome solar selective absorber.** Lampert, C.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 19p. (CONF-800439—6). NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

The characteristics of black chrome, a solar selective absorber, have been the object of much interest by solar materials scientists. For this study, a well known coating, Harshaw Chemical Company's Chromonyx was selected for detailed scrutiny of its properties and degradation modes when exposed to high temperatures. Both as-plated and annealed microstructural models were presented. Technical means used in this microstructural characterization were: scanning and transmission electron microscopy, Auger depth profiling hemispherical reflectance and energy dispersive x-ray analysis. From these results a physical metallurgical model for wavelength selective properties of the coating was developed. Thus, it was observed that black chrome degraded as Cr_2O_3 oxide particles grew and chromium depleted. This effect was pronounced in air and to a lesser degree in medium vacuum. Oxidation by preferential diffusion and outgassing which causes structural changes, may take place.

25791 (RFP—3021) **Aluminum-silver alloy films for solar reflectors.** Adams, R.O.; Nordin, C.W.; Masterson, K.D. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant; Solar

Energy Research Inst., Golden, CO (USA)). 1980. Contract AC04-76DP03533. 14p. (CONF-800439—5). NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Films of aluminum-silver alloys have been formed using triode sputtering. Films with a wide variety of composition have been produced and evaluated. Films deposited at low substrate temperatures have a high specular reflectance. At higher temperatures two phase alloys form which have rough low reflecting surfaces.

25792 (RTI—1708/00-03SA) **Non-glass glazings. Semi-annual report, October 1, 1979-March 31, 1980.** (Research Triangle Inst., Research Triangle Park, NC (USA)). Apr 1980. Contract AC04-78CS30132. 71p. NTIS, PC A04/MF A01.

The activities of the past six months have included analyses of field tested silicone samples by determination of intrinsic transmittance losses, transmittance loss caused by dust retention, and changes in surface morphology. In addition, FTIR spectra of these samples have been obtained. Commercial low molecular weight polydimethylsiloxane samples have been exposed to various wavelength ranges of ultraviolet radiation. New accelerated solar ultraviolet exposure tests have been initiated using a more intense ultraviolet source and a filter to eliminate wavelengths below 280 nm which are not present in the solar radiation at the earth's surface. A polydimethylsiloxane has been synthesized that is free of the anomalous 280 nm UV absorbance found in most commercially prepared samples and which may promote photodegradation. Virgin silicone glazing samples have been sent to Sandia Laboratories for laboratory evaluation of dirt retention.

25793 (SAND—79-2044C) **Field experience with solar concentrating collector control systems.** Gerwin, H.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 4p. (CONF-800805—6). NTIS, PC A02/MF A01.

From Joint automatic control conference; San Francisco, CA, USA (13 Aug 1980).

Various types of solar-concentrating collectors have been tested and evaluated. Each collector type has a different control system that includes a sun tracker system sensor, fluid-flow control, and safety cricuits for equipment protection. The sun tracker system sensors that have been tested include shadow-band, linear-concentrated flux, computer-driven (ephemeris), optical balance, and linear-flux integration. Most of the systems evaluated were early development models and comparisons are made on the basis of field-test conditions. Several fluid flow control approaches were included with the collectors. Generally, the fluid controls were designed to maintain a constant temperature by either varying the pump speed or a control valve. The safety circuits were designed to operate on signals such as overtemperature, insufficient fluid flow, and overtravel. Component failures and corrective actions are discussed herein.

25794 (SAND—80-0433) **SCRAM: a fast computational model for the optical performance of point fucus solar central receiver systems.** Bergeron, K.D.; Chiang, C.J. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 41p. NTIS, PC A03/MF A01.

Because of the complexities of heliostat shadowing and blocking calculations, computational models for the optical performance of point focus central receiver (PFCR) systems tend to be too slow for many important applications, such as optimization studies based on performance with realistic weather data. In this paper, a mathematical approximation procedure, designated Sandia Central Receiver Approximation Model (SCRAM) will be described. Rather than simulating the system components from first principles, it relies on data generated by the DELSOL code of Dellin and Fish for the optical performance of PFCR systems, and abstracts a mathematical model using a stepwise regression procedure. The result is a computational procedure which allows the user to define the heliostat field boundaries and tower height arbitrarily, generating a model for optical field performance, including shadowing, blocking, cosine, losses, and atmospheric attenuation, and which requires only a polynomial evaluation for each set of sun angles. A comparison with DELSOL for three different fields on three representative days indicates that the rms error of the approximation is 1-3% and that the new code is 1,000-3,000 times as fast as DELSOL. It is also shown that one reason that the accuracy in field performance predictions is higher than that of the generting function for the model is that much of the error in the generating function is due to an oscillatory behavior associated with a moire pattern in the optical response of the heiostat field.

25795 (SAND—80-7007) **Laminated Fresnel lenses.** Jebens, R.W. (RCA Labs., Princeton, NJ (USA)). Apr 1980. Contract AC04-76DP00789. 27p. NTIS, PC A03/MF A01.

A fabrication method for making plastic-on-glass laminated Fresnel lenses is discussed. These Fresnel lenses are for application in an RCA solar photovoltaic concentrator array now in the prototype stage of development. This laminated Fresnel lens fabrication method consists of making a Dow Corning J RTV silastic rubber mold of a master lens array. This mold is used to vacuum cast only the lens facets onto a low-iron tempered-glass substrate with an epoxy resin such as Hysol 0S 1000, a bisphenol-A resin with a flexibilizer that is anhydride cured. Cast acrylic Fresnel lens arrays commercialy available have potential cleaning and abrasion problems, have very large thermal expansion, and have dimensional uncertainties in their manufacture. The laminated lens is dimensionally stable with low thermal expansion, has good cleaning characteristics, and is very inexpensive in materials cost. The measured transmission of such a lens on low-iron glass is 80.4% compared with 85.1% for a cast acrylic lens, and the optical quality is good enough for application in the 100X to 200X concentration range. An approach to making large lens arrays (3 by 6 ft) on a commercial scale is explored.

25796 (SERI/TP—245-430, pp 61-67) **Collector array performance of instrumented sites in the National Solar Data Network.** McCumber, W.H. (IBM Corp., Huntsville, AL). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Data acquired by the National Solar Data Network (NSDN), as part of the National Solar Heating and Cooling Demonstration Program, has been converted into objective empirical collector array performance information. This information was presented to the solar community at the 1979 Department of Energy Regional Solar Update Conferences, in the form of computer-generated tabular and graphical data. This paper illustrates a number of extractions which may be obtained from the Collector Array Performance Report. Examples include: causes of deviation of array performance from single panel test performance; variations of collector array performance between sites; variations of sngle site array performance from month to month; typical performance expectations for the generic collector types; and a guide to collector component selection for generic solar energy system designs.

25797 (SERI/TP—245-430, pp 167-171) **Hail resistance of solar collectors with tempered glass covers.** Loef, G.O.G.; French, R.R. (Colorado State Univ., Ft. Collins). 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

On 30 July 1979, an intense hailstorm passed through Fort Collins, Colorado, leaving estimated property damage of $50 million. Most of the hailstones were of golfball size, but many were as large as a softball. Among 11 solar heated buildings in the main hailpath, 10 were provided with collectors in which tempered glass covers were used. Six of these collectors were not damaged, two suffered one broken cover glass each, and a 700-panel collector on a new county building had seven broken covers. Two covers in a 26-panel collector glazed with ordinary 1/8 inch untempered glass were punctured. Steel automobile bodies were heavily dented, roofs were penetrated by large hailstones, and greenhouses with glass and fiberglass roofs were demolished, but there was no significant damage to solar collectors in this intense hailstorms. Information on the solar instalations affected by the storm, photographs of damage, and conclusions on the insignificant risk of hail damage to well-designed solar collectors are included.

25798 (SERI/TP—333-591) **Analytical modeling of line focus solar collectors.** Wright, J.D. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 8p. (CONF-800805—1). NTIS, PC A02/MF A01.

From Joint automatic control conference; San Francisco, CA, USA (13 Aug 1980).

Solar thermal electric power generation systems and industrial process heat systems generating steam through flash vaporization require a constant outlet temperature from the collector field. This constant temperature is most efficiently maintained by adjusting the circulating fluid flow rate. Successful design of analog controllers for this regulation requires knowledge of system dynamics and the nonlinear nature of the system parameters. Simplified models relating deviations in outlet temperature to changes in inlet temperature, insolation, and fluid flow rate illustrate the basic responses and the distributed-parameter nature of line focus collectors. Detailed models are used to develop transfer functions and frequency response curves useful for design.

25799 (SERI/TR—34-093) **Effect of circumsolar radiation on performance of focusing collectors.** Bendt, P.; Rabl, A. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 58p. NTIS, PC A04/MF A01.

Circumsolar radiation is one of several factors, along with optical errors (contour, tracking, etc.), that determine the size and shape of the solar image at the receiver of a concentrating collector. The sensitivity of a collector to circumsolar radiation depends on insolation conditions and on collector parameters; it increases with geometrical concentration ratio and decreases with operating threshold. The Lawrence Berkeley Laboratory (LBL) circumsolar data are

used to develop fast computational procedures for calculating the effect of circumsolar radiation on both the instantaneous and the long-term average performance of focusing collectors. For predictions of long-term average performance, a standard synthetic circumsolar scan has been developed that describes the brightness distribution of the solar disk (limb darkening) and of the circumsolar region. The radiation intercepted by a receiver is calculated separately for the solar portion and for the circumsolar portion of this standard sun shape, and these two contributions are then weighted according to the long-term average circumsolar ratio for the location and period under study.

25800 (SERI/TR—631-336) **Optical analysis of point focus parabolic radiation concentrators.** Bendt, P.; Rabl, A. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 39p. Dep. NTIS, PC A03/MF A01.

A simple formalism is developed for analyzing the optical performance of point focus parabolic radiation concentrators. To account for off-axis aberrations of the parabola, an angular acceptance function is defined as that fraction of a beam of parallel radiation incident on the aperture which would reach the receiver if the optics were perfect. The radiation intercepted by the receiver of a real concentrator is obtained as a convolution of angular acceptance function, of optical error distribution, and of angular brightness distribution of the radiation source. Losses resulting from absorption in the reflector or reflection at the receiver are treated by a multiplicative factor rho α where rho = reflectance of the reflector and α = absorptance of the receiver. For numerical calculations, this method is more accurate and less time-consuming than the ray-tracing method. In many cases, there are acceptable approximations whereby the results can be obtained by reading a graph or evaluating a simple curve fit.

25801 (SERI/TR—8043-2) **Cost of heliostats in low volume production.** Drumheller, K.; Williams, T.A.; Dilbeck, R.A.; Allison, G.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1980. Contract EG-77-C-01-4042. 48p. NTIS, PC A03/MF A01.

This study indicates that in small volumes, heliostats can be produced at an installed cost of approximately 200 $/M^2 for a 49.053 m^2 heliostat. Initial one-time costs of $10 to $15 million would be required, although part of the one-time costs are recoverable. This study provides estimated costs of heliostats that are produced in a plant operating on a continuous basis for a period of four years at a production rate of 2,500 heliostats per year. This scenario was selected somewhat arbitrarily as a scenario that could lead to heliostat market of 5,000 to 10,000 units per year.

25802 **Simplified technique for comparing the effectiveness of collector absorber coatings.** Collier, R.K. (Los Alamos Sci Lab, NM). *Sol. Energy;* **23**: No. 5, 455-458(1979).

The paper formulates a universal graphical concept that requires a minimum of calculation for comparing the relative effectiveness of various selective surfaces. 2 refs.

25803 **Plasma-sprayed coatings for very high temperature solar absorbers.** Schreyer, J.M.; Schmitt, C.R.; Hays, R.A.; Farwell, D. (Oak Ridge Natl Lab, Tenn). pp vp of AES coatings for solar collectors symposium. Winter Park, FL; American Electroplating Society, Inc. (1979).

From 2. American Electroplaters Society symposium on coatings for solar collectors; St Louis, MO, USA (16 Oct 1979).

Plasma-sprayed coatings on steel plates were tested at temperatures from 200°C to 1000°C. Analysis of the specimens before and after testing showed erbium dodecaboride (ErB_{12}), yttrium hexaboride (YB_6), titanium diboride (TiB_2), and chromium oxide (Cr_2O_3) to be stable above 600°C. A heat balance on the water-cooled specimens of these coatings showed 71% to 97% heat recovery efficiency.

25804 **Metal foils for direct application of absorber coatings on solar collectors.** Lampert, C.M. (Univ of Calif, Lawrence Berkeley Lab). pp vp of AES coatings for solar collectors symposium. Winter Park, FL; American Electroplating Society, Inc. (1979).

From 2. American Electroplaters Society symposium on coatings for solar collectors; St Louis, MO, USA (16 Oct 1979).

The basic materials and processing associated with production are discussed. Also covered are details of heavier metal strips for direct fabrication. Techniques including bonding methods and the use of adhesives are surveyed. Commercial solar foil manufacturers are covered, along with new research efforts in this area. Advantages and disadvantages are outlined, with specific recommendations. 12 refs.

HEAT STORAGE

REFER ALSO TO CITATION(S) 25914

25805 (CONF-791232—, pp 43-46) **Solar applications analysis for energy storage.** Blanchard, T. 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The Department of Energy, Division of Energy Storage Systems (STOR) recently started an analysis of the role of energy storage as it relates to solar energy systems to (1) determine where storage technologies can best support solar energy applications, (2) assess the current status of storage technologies, (3) establish requirements and specifications for storage technologies and (4) evaluate the adequacy of the current storage R and D program to meet these requirements. The basic objective of the study is to determine where the greatest potential exists for energy storage in support of those solar energy systems which could have a significant impact on the US energy mix. Such a determination could consequently provide program guidance as to how STOR can best expand their R and D resources to meet this potential.

25806 (CONF-791232—, pp 115-124) **Solar Thermal Power Storage Applications.** Radosevich, L.G. (Sandia Labs., Livermore, CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

This overview describes the implementation of the applications elements of the Thermal Energy Storage for Solar Thermal Applications (TESSTA) program. The TESSTA program evolved from a joint plan of the DOE Division of Energy Storage Systems (STOR) and Central Solar Technologies (CST). The program includes the accelerated development of thermal storage technologies matched to solar thermal power system requirements and scheduled milestones. The program concentrates on storage development in the FY80 to 85 time period with emphasis on the more near-term solar thermal power system applications. The basic strategy of the program is both aggressive and flexible. Reflecting the current direction of the Thermal Power Systems (TPS) Branch, CST, storage for repowering/industrial retrofit, total energy, and small community system applications is stressed in the early years.

25807 (CONF-791232—, pp 125-130) **Thermal storage experience at the MSSTF and plans for the future.** Harrison, T.D.; Randall, R.A. (Sandia Labs., Albuquerque, NM). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The purpose of this presentation is (1) to review the background of thermal storage development at the Midtemperature Solar Systems Test Facility (MSSTF) at Sandia Laboratories, (2) to define the problems which have been encountered, (3) to outline a course of action for resolving these problems, (4) to determine scaling effects of going from laboratory models to full-size applications, and (5) to apply the lessons learned to thermal storage needs in near-term solar projects.

25808 (CONF-791232—, pp 131-140) **Thermal energy storage effort at JPL.** Young, D.L. (Jet Propulsion Lab., Pasadena, CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Research at JPL on thermal energy storage is outlined. Latent heat storage for parabolic collector thermal power plants (Rankine, Brayton, and Stirling cycles) is emphasized. (WHK)

25809 (CONF-791232—, pp 141-155) **Internally insulated thermal storage system development program.** Scott, O.L. 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The purpose of the program is to define a cost effective thermal storage system for a solar central receiver power system using molten salt stored in internally insulated carbon steel tanks. The program is divided into four tasks: testing of internal insulation materials in molten salt; preliminary design of storage tanks, including insulation and liner installation; optimization of the storage configuration; and definition of a subsystem research experiment to demonstrate the system. Status of the program is reported.

25810 (CONF-791232—, pp 157-161) **Sandia Laboratories in-house activities in support of solar thermal large power applications.** Mar, R.W. (Sandia Labs., Livermore, CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Research activities have been planned and carried out in direct support of the development of thermal energy storage subsystems for solar thermal large power applications. The emphasis has been on characterizing the behavior of molten nitrate salts with regard to thermal decomposition, environmental interactions, and corrosion. The results to date and future activities are summarized.

25811 (CONF-791232—, pp 163-171) **High temperature underground thermal energy storage system for solar energy.** Collins, R.E. (Univ. of Texas, Austin). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The objective of this project is to establish the feasibility of high temperature underground thermal storage of energy and arrive at a practical system design. Results to date indicate that salt cavern storage of hot oil is both technically and economically feasible as a method of storing huge quantities of heat at relatively low cost. One particular system identified in this study utilizes a gravel filled cavern leached within a salt dome. Thermal losses are shown to be less than one-percent of cyclicly-transferred heat. A system like this having a 40 MW/sub t/ transfer rate capability and over eight hours of storage capacity is shown to cost about $13.50 per KWh/sub t/.

25812 (CONF-791232—, pp 173-181) **Development of a thermal storage module using modified anhydrous sodium hydroxide.** Rice, R.E.; Rowny, P.E. (Comstock and Wescott Inc., Cambridge, MA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The project goals are to conduct laboratory scale testing of a modified anhydrous NaOH latent heat storage concept for small solar thermal power systems such as total energy systems utilizing organic Rankine systems. Under a previous contract, NAS3-20615, a module was tested and a computer simulation code developed. This follow-on effort consists of diagnostic test on the module and investigation of alternative heat transfer fluids and heat exchange concepts. Post test analysis of the previously tested module indicated no internal corrosion or leakage. The module has been refilled with Thermkeep (91.8% Anhydrous NaOH, 8% $NaNO_3$, and 2% MnO_2) and prepared for a second test series using an alternative heat transfer fluid, Caloria HT-43. Silicone B was initially to be used; however, this fluid was found to be mildly reactive with the NaOH. The computer simulation model has been modified to predict the performance of this module in a solar total energy system environment. In addition, the computer model has been expanded to investigate parametrically the incorporation of a second heat exchange inside the TES module which will vaporize and superheat the Rankine cycle power fluid.

25813 (CONF-791232—, pp 183-190) **High-temperature molten salt thermal energy storage systems for solar applications.** Petri, R.J.; Claar, T.D. (Inst. of Gas Tech., Chicago, IL). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The project goals are (1) determine the feasibility of using carbonate salts as storage media for high temperature applications (700 to 870°C); (2) review carbonate salt properties and select six salts as candidate media; (3) investigate methods to enhance heat transfer through solid salt; (4) conduct carbonate salt-containment material compatibility studies that include 3000 hour screening tests; and (5) measure thermophysical and transport properties of the two most promising salts. The review of properties is complete with the following six salts selected for compatibility studies: three pure carbonates, K_2CO_3, Li_2CO_3 and Na_2CO_3; two eutectic mixtures, $BaCO_3/Na_2CO_3$ and $K_2CO_3/NaCO_3$, and one off-eutectic mixture of Na_2CO_3/K_2CO_3. The compatibility studies are scheduled to be completed by mid-1980.

25814 (SAND—80-8218) **Thermal Energy Storage for Solar Thermal Applications Program. Progress report, October 1979-March 1980.** Radosevich, L.G. (Sandia National Labs., Livermore, CA (USA)). May 1980. Contract AC04-76DP00789. 100p. NTIS, PC A05/MF A01.

The FY80 program and the five year plan are described for the six tasks: (1) storage for water/steam cooled collector receiver; (2) storage for molten salt cooled sensible heat collector/receiver; (3) storage for liquid metal cooled sensible heat collector/receiver; (4) storage for gas cooled sensible heat collector receiver; (5) storage for organic or silicone fluid cooled sensible heat collector/receiver; and (6) dish mounted latent heat buffer storage. Current projects are described. (WHK)

25815 (SERI/TP—245-430, pp 157-161) **Thermal characteristics of a rock storage unit for solar energy.** Brinsfield, R.B. (Univ. of Maryland, Cambridge); Felton, K. 1979.

From 2. annual solar heating and cooling systems operational results conference; Colorado Springs, CO, USA (27 Nov 1979).

Solar collection, storage, and distribution system was designed and installed to supply heated air was designed and installed to supply heated air to an environmental test chamber at the University of Maryland Broiler Research Facility at Salisbury, Maryland. The collector consists of eight 1.22 x 4.88 m panels providing approximately 41.81 m^2 effective collector area. The rock storage unit was constructed with two sheets of 1.59 cm plywood separated by 5.08 x 15.24 cm studs on 60 cm centers. The area between the studs was filled with 15.24 cm of fiberglass insulation. The unit was filled with approximately 20.8 x 10^3 kg of No. 6 washed gravel. Tests were conducted to determine collector efficiency, electrical power usage, pressure drop, and thermal characteristics of the system at air flow rates of 23, 15, and 10 m^3/min. Tests results indicate that for the range of air flow rates considered, collector efficiencies decrease as air flow rates decrease. The results also indicate that for a given air flow rate the pressure drop through the rock storage increases linearly. For the range of air flow rates considered, tests also indicate that electrical power usage increases linearly as air flow rates increase. In addition, the study showed that pressure drop across the rock storage (ΔP) varied as the square of the apparent velocity $(V)^2$. The results also indicate that thermal stratification along the centerline of the rock storage increases as air flow rates decrease.Finally, as air flow rates decrease tests show an increase in thermal stratification from the centerline of the rock storage perpendicular to the direction of air flow.

GEOTHERMAL ENERGY

25816 (LASL—79-8) **Summary of talks.** (Los Alamos Scientific Lab., NM (USA)). Jan 1979. Contract W-7405-ENG-36. 36p. (CONF-7804107—(Summ)). NTIS, CC A03/MF A01.

From Hot dry rock geothermal workshop; Los Alamos, NM, USA (20 Apr 1978).

Twenty-two summaries of the talks given at the LASL 1978 Hot Dry Rock Geothermal Information Conference are presented. (MHR)

RESOURCE STATUS AND ASSESSMENT

USA

25817 (DOE/ET/28459—1) **Industry participation in DOE-sponsored geopressured geothermal resource development. Final report, 1 September 1977-30 April 1979.** Coffer, H.F. (CK GeoEnergy Corp., Las Vegas, NV (USA)). 1979. Contract AC08-77ET28459. 468p. NTIS, PC A20/MF A01.

A series of DOE/Industry forums were carried out to keep industry advised of the DOE program to develop the geopressured geothermal resources of the Gulf Coast. A total of eighteen meetings were held with registered attendance of 621 representing a good cross section of industry, state, and federal agencies. An Overview Group and four working subgroups - site selection, drilling and testing, environmental/laboratory research, and legal institutional were established to subdivide the DOE programs into areas of interest and expertise. During the contract period three overview, four site selection, three drilling and testing, five environmental/laboratory research and three legal/institutional meetings have been conducted. Interest in and attendance at the meetings continue to grow reflecting increased industry contact with the DOE Geopressured Geothermal Resource Development Program. Two other studies were carried out for DOE under this contract; a Salt Water Disposal Study and an Industry Survey to evaluate the DOE Resource Development Program. The Salt Water Disposal Study reviewed subsurface salt water disposal experience on the Texas and Louisiana Gulf Coast. This preliminary study concluded that subsurface brine disposal should be possible in the areas of interest with adequate evaluation of the geology of each area and a well designed and constructed surface and subsurface facility. The industry survey indicated general satisfaction with the technical design of the resource evaluation program but felt the program should be moving faster.

25818 (DOE/NV/10039—1) **Assessment of geothermal resources of Caliente, Nevada.** Trexler, D.T.; Flynn, T.; Koenig, B.A.; Bruce, J. (Nevada Bureau of Mines and Geology, Reno (USA); Nevada Univ., Reno (USA)). Mar 1980. Contract AC08-79NV10039. 30p. NTIS, PC A03/MF A01.

An assessment of the geothermal resources of Caliente, Nevada was made to provide information on resource characteristics and to site 2 (two) 500 ft (152 m) test wells to confirm the resource. The strategy used in the resource assessment employed a logical sequence of work elements that included 1) baseline data collection, 2) field investigations, 3) laboratory analyses and 4) data interpretation and synthesis. Airphoto interpretation indicated that a series of normal faults produced a stepped arrangement in the canyon walls on the west side of Meadow Valley Wash north of downtown Caiente. This area coincides with the area of known geothermal occurrences. Temperature measurements in existing wells indicate a rapid cooling of the geothermal waters as they mix with cold groundwater flows in Meadow Valley Wash. Soil mercury analyses range from 15 ppB to as high as 120 ppB. Trends in soil mercury content may indicate the presence of buried faults. Temperature measured in 2-meter deep auger holes indicated temperatures as high as 40°C in an area north of the Lincoln County Medical Facility. Interpretation of chemical analyses, both major and minor, of waters collected from wells and streams in the area failed to conclusively

show any mechanisms for the mixing of thermal and nonthermal waters. The selection of sites for the 2 (two) 500 ft (152 m) reservoir confirmation wells was made using the results of temperature surveys, geologic structure and historic observations.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

25819 (LA—8343-MS) **Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.** Achenbach, J.D.; Bazant, Z.P.; Dundurs, J.; Keer, L.M.; Nemat-Nasser, S.; Mura, T.; Weertman, J. (Northwestern Univ., Evanston, IL (USA). Technological Inst.). Feb 1980. Contract W-7405-ENG-36. 160p. NTIS, PC A08/MF A01.

Resuls of analytical and experimental studies on hydraulic fracturing and on the characterization and modeling of hot dry rock geothermal energy reservoirs are presented. The first four Chapters are concerned with problems of thermal cracking and heat transfer, with fluid flow through large cracks, and with the stable and unstable growth of water-filled cracks under internal pressure and thermal loading. Experiments are reported, which present visually observable hydraulic fractures in transparent materials to demonstrate the interaction between hydraulic fractures and the development of thermal cracks. Seismic detection of hydraulic fractures is discussed, and a method to invert crack-scattering data is presented. Separate abstracts were prepared for each of the six chapters.

25820 (LBL—8264) **SHAFT78: a two-phase multidimensional computer program for geothermal reservoir simulation.** Pruess, K.; Schroeder, R.C.; Witherspoon, P.A.; Zerzan, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 129p. NTIS, PC A07/MF A01.

The computer program SHAFT78 was developed to compute two-phase flow phenomena in geothermal reservoirs. The program solves transient initial-value problems with prescribed boundary-conditions in up to three space dimensions. The solution method is an explicit-implicit IFD approach which does not distinguish between 1, 2, or 3-D coordinate systems and allows a flexible choice of the shape of the discrete grid elements. The mass-and-energy equations are formulated in conservative form. The stability and convergence of the algorithm is controlled by an automatic choice of time steps - partially controlled by the user. Although the program has been developed for use in simulating production and injection in geothermal reservoirs, there are other two-phase problems for which it is either immediately applicable, or for which it can be modified to be applicable. All fluid parameters, such as viscosity, heat capacity, heat conductivity, etc., can be specified as functions of temperature and pressure, and all parameters can vary with position. The program can handle up to seven different anisotropic rocks, with all rock parameters assumed to be independent of position, temperature, and pressure. (MHR)

USA

25821 (DOE/ET/28461—T1) **Wilcox sandstone reservoirs in the deep subsurface along the Texas Gulf Coast - their potential for production of geopressured geothermal energy. Final report.** Debout, D.G.; Weise, B.R.; Gregory, A.R.; Edwards, M.B. (Texas Univ., Austin (USA). Bureau of Economic Geology). Oct 1979. Contract EY-76-S-05-4891. 229p. NTIS, PC A11/MF A01.

The following subjects are included: regional setting, stratigraphic sections, Lower Wilcox sandstone distribution, formation pressure, formation temperature used to delineate geothermal fairways, Zapata Fairway, Duval Fairway, Live Oak Fairway, De Witt Fairway, Colorado Fairway, and Harris Fairway. Depositional and structural style, formation pressures and temperatures, porosity and permeability, formation water salinity, and Cuero Prospect are covered for De Witt Fairway. Depositional and structural style, formation and fluid properties, and Eagle Lake Prospect are covered for Colorado Fairway. (MHR)

25822 (ORO—4937-T2) **Geopressured-geothermal test of the EDNA Delcambre No. 1 well, Tigre Lagoon Field, Vermilion Parish, Louisiana: geology of the Tigre Lagoon Field, Pleistocene Basin. Final report.** (McNeese State Univ., Lake Charles, LA (USA)). Oct 1978. Contract EY-76-S-05-4937. 53p. NTIS, PC A04/MF A01.

The geology and hydrology of the Tigre Lagoon Gas Field and the structural and depositional basin in which it occurs, as described, define a hydrodynamic system which has been in operation for millions of years. Fluid entrapment and geopressuring of the deposits has resulted in steepened geothermal gradients, accelerated maturation and thermal degradation (cracking) of fluid hydrocarbons, thermal diagenesis of certain clay minerals with release of much bound and intracrystalline water as free pore water, and a systematic fluid migration history controlled by the sand-bed aquifers in the basin, and by upward leakage at growth faults wherever fluid pressures approached or exceeded rock pressures. Observed geotemperature, geopressure, water salinity, and natural gas occurrence in the study area conform with the conceptual model developed.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

25823 (DOE/ET/2700 02—6) **Geothermal Exploration and Assessment Technology Program (review), including a report of the Reservoir Engineering Technical Advisory Group.** Nielson, D.L. (ed.). (Utah Univ., Salt Lake City (USA). Earth Science Lab.). Dec 1979. Contract AC07-79ET27002. 132p. NTIS, PC A07/MF A01.

The FY 1979 Program, recommended seismic surveys in conjunction with DOE/DGE's industry coupled program in the Northern Basin and Range Province, and the objectives of the Marina del Rey conference are presented. Final reports of six committees which met to define the state-of-the-art in geothermal exploration and to recommend exploration technology development are included. These committees are: structure, stratigraphy, and igneous processes; exploration architecture; electrical methods; seismic methods; thermal methods; water/rock interaction; and reservoir engineering. (MHR)

25824 (DOE/ET/27023—4) **Direct heat resource assessment: Phase II, year 1. Final report, February 1, 1979-January 31, 1980.** Thomas, D.M.; Cox, M.E.; Kauahikaua, J.P.; Mattice, M.D. (Hawaii Univ., Honolulu (USA). Hawaii Inst. of Geophysics). Feb 1980. Contract AS03-79ET27023. 80p. NTIS, PC A05/MF A01.

During 1979 reconnaissance field surveys were conducted on the islands of Hawaii, Maui, and Oahu with the objective of confirming groundwater chemical data and geophysical data compiled during the preliminary regional assessment of Phase I of the Direct Heat Resource Assessment Program. The exploration techniques applied include (1) groundwater chemistry, (2) mercury-radon surveys, (3) isotopic composition of groundwaters, (4) time domain electromagnetics, and (5) Schlumberger resistivity surveys. The results of these surveys can be classified as follows: (1) Hawaii: Kailua-Kona, strong geochemical anomalies; Kawaihae, strong geophysical anomalies, moderate to strong geochemical anomalies; Hualalai northwest rift, weak geochemical and moderate geophysical anomalies; South Point, moderate to weak geophysical anomalies; Hualalai southeast rift, weak geophysical anomalies; Keaau, weak geophysical and geochemical anomalies; (2) Maui: Haiku-Paia, strong geochemical anomalies; Olowalu-Ukamehame canyons, moderate to strong geochemical and geophysical anomalies; Lahaina, weak geochemical and geophysical anomalies; (3) Oahu: Lualualei, moderate to strong geochemical and geophysical anomalies; Waimanalo-Maunawili, insufficient data.

25825 (DOE/ET/27242—3) **Economic incentive of geothermal resource development for direct applications.** Cassel, T.A.V.; Amundsen, C.B. (Technecon Analytic Research, Inc., Philadelphia, PA (USA)). Feb 1980. Contract AC02-79ET27242. 24p. NTIS, PC A02/MF A01.

As part of a mission-oriented program for accelerating the commercialization of geothermal energy, research is sponsored which concerns the quantitative analysis of investment decisions by industries involved in the development of geothermal resources. The results of a quick-response study conducted during the course of this research are discussed. The report specifically compares the relative investment incentive offered by two categories of geothermal ventures: (a) geothermal electric power projects; and (b) geothermal direct application projects. The attributes of discounted cash flows for several typical projects within each of the two categories are compared and, by using statistically-strong industry decision models previously developed, the likelihood of a favorable investment decision is estimated for each project.

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 25818, 25839

25826 (LA—8343-MS, pp 121-154) **Seismic detection of water-filled cracks.** Achenbach, J.D.; Viswanathan, K. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

Analytical studies are presented which bear on the feasibility of mapping a hydraulically-induced crack by measuring the reflections, transmissions and diffractions of mechanical signals emitted by a point source. Recent results on the direct problem of wave diffraction by empty and water-filled flat cracks are briefly summarized. Particular attention is devoted to an approach whereby the interaction of the crack faces due to the presence of water in the crack, and due to contact between the rough faces of the crack, is accounted for by a relation between the transactions on the crack

faces and the time-rates of change of the crack-opening-displacements. This relation takes viscous effects into account. Parametrical studies are presented for the reflection and transmission coefficients, where the angle of incidence and a parameter describing the relative resistance to normal and tangential crack-opening displacements are taken as the variables. The effects of scattering by the edge of the crack are studied on the basis of a far-field integral representation for the scattered field, in conjunction with the assumption that the local separation of the crack faces computed on the basis of reflection and transmission considerations, produces an acceptable approximation to the crack-opening displacements. A one-dimensional formulation is briefly considered for the case that the crack is not distinct, but rather is represetned by an inhomogeneity of finite width which is characterized by different wave velocities than in the adjoining materials.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 25818

EXPLORATORY DRILLING AND WELL LOGGING

25827 (DOE/ET/28417—1) **Geothermal observation wells, Mt. Hood, Oregon. Final report, October 4, 1977-July 9, 1979.** Covert, W.F.; Meyer, H.J. (Northwest Geothermal Corp., Portland, OR (USA)). Nov 1979. Contract ET-78-C-08-1565. 32p. NTIS, PC A03/MF A01.

Exploration drilling operations were conducted which included the deepening of an existing hole, designated as Old Maid Flat No. 1, from 1850 ft (564 m) to 4002 (1220 m) on the western approaches to Mt. Hood and the drilling of three new holes ranging from 940 ft (287 m) to 1340 ft (409 m). The Clear Fork hole, located in Old Maid Flat, was drilled to 1320 ft (402 m). The Zigzag hole was drilled to 940 ft (287 m) at the southwestern base of Mt. Hood in the Zigzag River valley. The remaining hole was drilled on the Timberline Lodge grounds which is on the south flank of Mt. Hood at an elevation of about 6000 ft (1829 m) above sea level. The deepening project designated as Old Maid Flat No. 1 encountered a maximum bottom hole temperature of about 180°F (82°C) and is to this date the deepest exploratory hole in the Mt. Hood vicinity. No significant drilling problems were encountered. The Clear Fork and Zigzag River holes were completed without significant problems. The Timberline Lodge hole encountered severe drilling conditions, including unconsolidated formations. Two strings of tools were left in the hole from structural collapse of the hole. The hole was scheduled as a 2000 ft (610 m) test. Drilling did not proceed beyond 1350 ft (412 m) and due to junk it was unobstructed to a depth of 838 ft (255 m). Observation pipe was installed to 735 ft (224 m) due to further disintegration of the hole. The work was prematurely terminated due to weather conditions.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 25817, 25835

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 25279

25828 (COO—5085-4) **Energy analysis of geothermal-electric systems.** Herendeen, R.A.; Plant, R. (Illinois Univ., Urbana (USA). Office of Vice Chancellor for Research). Dec 1979. Contract ET-78-S-02-5085. 215p. NTIS, PC A10/MF A01.

Standard energy analysis was applied to 4 types of geothermal-electric technologies: liquid dominated, hot dry rock, geopressure, and vapor dominated. It was found that all are net energy producers. Expected uncertainties are not large enough to threaten this conclusion. Vapor dominated, the only technology in current commercial use to produce electricity in the US, has the highest energy ratio (13 +- 4). These results for energy ratio are equal to or less than some from other workers. In the case of liquid dominated, environmental control technology has a considerable energy requirement.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 25828, 25841

25829 (DOE/ET/27202—1) **Reinjection of fluids into a producing geopressured reservoir. Topical report.** (Systems, Science and Software, La Jolla, CA (USA)). Oct 1979. Contract AC08-79ET27202. 32p. NTIS, PC A03/MF A01.

A reservoir simulator (MUSHRM) was employed to examine the effects of reinjecting the processed brine on the longterm performance of a representative geopressured reservoir. These calculations indicate that reinjection can be used to substantially increase methane and brine production. The results suggest that power requirements for reinjection pumps can be met by either burning approximately two-thirds of the produced methane (This may in some cases negate the benefits of reinjection as far as methane production is concerned.), or by using the heat of the produced brine (320°F) to generate electric power. Assuming that electric power produced from hot brine is used to reinject the processed fluids, it appears that reinjection is a viable production strategy for increasing methane recovery from some geopressured systems. The attractiveness of reinjection to recover methane increases with increasing formation permeability, and decreasing formation compressibility.

25830 (UCID—18606) **Interim report: studies of boron deposition near geothermal power plants.** Koranda, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Apr 1980. Contract W-7405-ENG-48. 17p. NTIS, PC A02/MF A01.

Measurements in the Geysers area from April until October 1979 when the onset of seasonal rains limited field work are presented. Field studies involved the following three basic types of measurements: cooling tower drift deposition, plant ecological studies, and animal population studies. Brief summaries of the data are presented to demonstrate the types of information obtained. (MHR)

25831 (UCRL—83122(Rev.1)) **Processing of high salinity brines for subsurface injection.** Raber, E.; Thompson, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.; National Technical Services, Inc., Corvallis, OR (USA)). 6 Aug 1979. Contract W-7405-ENG-48. 10p. (CONF-800102—4). NTIS, PC A02/MF A01.

From International conference on geotechnical and environmental aspects of geopressure energy; Sea Island, GA, USA (13 Jan 1980).

Different chemical pretreatments and filtration methods were evaluated a possible means of clarifying and improving the injectivity of hypersaline brines. Based upon the concentration of suspended solids and chemical composition of the brine, the main emphasis was placed on evaluating downflow granular media (combinations of coal, garnet and/or sand) filters. Six different media combinations were evaluated over the three sites, utilizing test data from 4 inch diameter pilot filters. In addition, tests were conducted with one hollow fiber ultrafilter unit and two types of disposable cartridge filters. The test procedures employed in this study involved: (1) a bench-scale evaluation of pretreatment chemical aids, (2) pilot tests with and without chemical coagulants on downflow granular media filters, ultrafilters, And cartridge filters, and (3) particular techniques developed by LLL for the assessment of injectability utilizing filter membrane plugging factor tests. Over fifty inorganic salts and polymers were evaluated as coagulants/flocculants by a combinations of jar testing and bench-scale filtration techniques. In summary, the results showed that high-molecular weight anionic polymers and aluminum salts (or aluminum salts plus nonionic polymers) were the most effective. Average turbidities were lowered from 10 to .20 NTU after addition of these chemicals. Anionic polymers have also been found to be effective coagulants in hypersaline geothermal brine.

BY-PRODUCTS

25832 (UCID—18646) **Defluoridation study for Boise geothermal water.** Rigdon, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Jun 1980. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01.

Methods of removing fluorides from water are reviewed and recommendations are made for treating geothermal water used by the Boise Geothermal Project, Boise, Idaho. The Boise geothermal water except for its high fluoride content would be high quality, suitable for primary drinking water. Fluoride ranges from about 15 to 25 mg/l in water from various wells in the Boise region where the Project plans to obtain hot water. Four techniques for removing fluorides from water have been studied extensively during the past 15 years or so. Electrodialysis and reverse osmosis are useful in reducing total dissolved solids from brackish water, but are nonspecific and are too expensive for treatment of the Boise geothermal water. Selective precipitation is a widely used technique for treating water, but would also prove expensive for the Boise geothermal water because of the relatively high solubility of fluoride salts and consequently high concentration (and cost) of precipitants required to reduce the fluorides to an acceptable level. Ion-exchange separation using activated alumina as the exchange medium appears to be the most promising technique and we recommend that some labora-

tory and pilot studies be conducted to establish suitability and operating boundaries.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 25825

25833 (COO—27242-1) **Geothermal power plant investment decisions. Interim report, June 1-November 30, 1979.** Cassel, T.A.V.; Amundsen, C.B.; Edelstein, R.H.; Blair, P.D. (Technecon Analytic Research, Inc., Philadelphia, PA (USA)). Dec 1979. Contract AC02-79ET27242. 61p. NTIS, PC A04/MF A01.

Investment decisions for financing the construction of geothermal power plants are discussed. Discussed here are the investment objectives of investor-owned electric utilities, municipal electric utilities, and potential third party financiers as determined from extensive reviews of literature, executive interviews and responses to mailed surveys. The framework is provided for a computerized quantitative decision model currently being developed at Technecon for investment and policy analysis applications. (MHR)

DESIGN AND OPERATION

25834 (CONF-800723—9) **Design and off-design operation of a dual-boiling binary geothermal power plant.** Bliem, C.J. Jr. (Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 15p. NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Portions of document are illegible.

The design of a 5 MW(e) geothermal plant using a binary fluid process is described. The second fluid is isobutane. This plant is presently under construction at Raft River, Idaho. A mathematical simulation of the plant is discussed. The heat exchangers were modeled by dividing them into segments in the direction of flow to permit local adjustments in heat transfer coefficients and fluid properties. Sensitivity of plant performance to geofluid temperature and flow rate, heat exchanger fouling and cooling water temperatures were investigated. Conventional correlations were used for the heat transfer coefficients except for the condensing coefficient, which was obtained from a recent study at Lawrence Berkeley Laboratory.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

25835 (DOE/ET/28460—2) **Investigation and evaluation of geopressured-geothermal wells. Summary of Gruy Federal's Well-of-Opportunity Program to January 31, 1980.** (Gruy Federal, Inc., Houston, TX (USA)). Mar 1980. Contract AC08-77ET28460. 51p. NTIS, PC A04/MF A01.

Scouting and monitoring techniques peculiar to geopressured-geothermal wells and legal problems are presented. The following are tabulated: priority wells actively monitored, industry contacts, and the summary of industry responses to well-or-opportunity solicitation. (MHR)

25836 (NVO—1528-2) **Investigation and evaluation of geopressured geothermal wells.** (Gruy Federal, Inc., Houston, TX (USA)). Mar 1978. Contract EG-77-C-08-1528. 49p. NTIS, PC A03/MF A01.

This group of wells-of-opportunity (WOOs) consists of four reentry candidates located in Southern Louisiana. The four Louisiana wells have penetrated a thick section of deep hot and geopressured Miocene or Oligocene sand. Thus the geologic risk is essentially eliminated. Each of these wells has been abandoned. Particular emphasis was placed on selecting wells which are reported to have been left in such a mechanical condition that the risk of reentry operations is low. Every effort will be made to further check any well chosen for unreported conditions. Description, reentry proecdure, testing procedures, and cost estimates are presented for each well. (MHR)

25837 (NVO—1528-3(Vol.1)) **Investigation and evaluation of geopressured-geothermal wells. Final report, Alice C. Plantation No. 2 well, St. Mary Parish, Louisiana. Volume I. Narrative report.** Lohse, A.; Willits, M.H. (Gruy Federal, Inc., Houston, TX (USA)). Dec 1978. Contract EG-77-C-08-1528. 119p. NTIS, PC A06/MF A01.

The first well on which testing was attempted was the Alice C. Plantation No. 2 Well, located in St. Mary Parish, Louisiana. Originally drilled by the Sun Oil Company to a total depth of 19,000 feet, this well was abandoned as a dry hole in January 1964. Gruy's reentry attempt ended with plugging and abandonment after a saltwater flow on September 17, 1978. All events and costs relating to the Alice C. Plantation well, from its initial selection as a reentry well through the plugging and abandonment operations are detailed. (MHR)

25838 (NVO—1528-5) **Investigation and evaluation of geopressured-geothermal wells. Notes on Gruy Federal's Well-of-Opportunity program.** (Gruy Federal, Inc., Houston, TX (USA)). Feb 1979. Contract EG-77-C-08-1528. 117p. NTIS, PC A06/MF A01.

Obtaining test data from geopressured aquifers along the Texas and Louisiana Gulf Coast by arranging to assume operation of wells already drilled and found nonproductive of conventional oil or gas accumulations before such wells were abandoned by the operators is described. The geopressured aquifers were tested after performing whatever additional operations were required. The monitoring and screening of all wells which might qualify is described. The major activities and important milestones are summarized. (MHR)

25839 (SAND—77-0828) **Geophysical sensing experiments on Kilauea Iki lava lake.** Hermance, J.F.; Forsyth, D.W.; Colp, J.L. (Sandia National Labs., Albuquerque, NM (USA)). Dec 1979. Contract AC04-76DP00789. 44p. NTIS, PC A03/MF A01.

The Hawaiian lava lake in the Kilauea Iki pit crater, resulting from the 1959 summit eruption of Kilauea volcano, has served as a natural laboratory for the continuing study of the petrology, rheology, and thermal history of ponded molten basalt flows in the field environment. During 1975 and 1976, a series of electromagnetic and seismic experiments were coordinated in an attempt to define the in-situ geophysical properties and the configuration of the molten lava core as closely as possible. Drilling and geophysical experiments in 1976 suggested that the solidified crust of the lava lake had a cool, resistive surface layer, undersaturated with water to a depth of 5 meters. A warm, wet layer containing appreciable water and/or steam was essentially isothermal (100°C) to 33 meters. From 33 to 45 meters the temperature climbed rapidly (from 100° to 1070°C) until a thin plexus of molten sills was encountered, interbedded with solid layers. Below this (50 meters) was apparently a layer having the highest temperature, lowest viscosity, and lowest density of olivine phenocrysts. At 70 meters, a transition zone to a crystalline mush was indicated, and finally (between 80 and 95 meters), solid basalt extended down to the preflow surface at a depth of 115 to 120 meters.

25840 (SAND—80-0703) **Geothermal Drilling and Completion Technology Development Program. Quarterly progress report, January-March 1980.** Varnado, S.G. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 214p. NTIS, PC A10/MF A01.

The progress, status, and results of ongoing Research and Development (R and D) within the Geothermal Drilling and Completion Technology Development Program are described. The program emphasizes the development of geothermal drilling hardware, drilling fluids, completion technology, and lost circulation control methods. Advanced drilling systems are also under development. The goals of the program are to develop the technology required to reduce well costs by 25% by 1983 and by 50% by 1987.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 26737

25841 (DOE/ET/27026—T2) **Geothermal steam muffler diffusers: the Geysers, California. Failure analysis report.** McAlpin, R.; Ellis, P.F. II. (Radian Corp., Austin, TX (USA)). Apr 1980. Contract AC02-79ET27026. 18p. NTIS, PC A02/MF A01.

The primary failure mechanism for the T304 diffusers was chloride induced stress corrosion cracking (sec.) Once SCC had progressed to a certain point, high cycle corrosion/fatigue proceeded to the final fracture. Alteration of the environment to prevent SCC is not feasible. The existing environment will also cause sulfide stress cracking (SSC) in susceptible materials; therefore, alternate materials must resist SSC as well as SCC. The very large amplitude operational stresses make heat treatment to relieve residual fabrication stress questionable for the prevention of SCC. (MHR)

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 25820

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

25842 (DOE/AL/10563—T1) **Geothermal reservoir well stimulation program. First-year progress report.** (Republic Geothermal, Inc., Santa Fe Springs, CA (USA)). Feb 1980. Contract AC32-79AL10563. 43p. NTIS, PC A03/MF A01.

The Geothermal Reservoir Well Stimulation Program (GRWSP) group planned and executed two field experiments at the Raft River KGRA during 1979. Well RRGP-4 was stimulated using a dendritic (Kiel) hydraulic fracture technique and Well RRGP-5

was stimulated using a conventional massive hydraulic fracture technique. Both experiments were technically successful; however, the post-stimulation productivity of the wells was disappointing. Even though the artificially induced fractures probably successfully connected with the natural fracture system, reservoir performance data suggest that productivity remained low due to the fundamentally limited flow capacity of the natural fractures in the affected region of the reservoir. Other accomplishments during the first year of the program may be summarized as follows: An assessment was made of current well stimulation technology upon which to base geothermal applications. Numerous reservoirs were evaluated as potential candidates for field experiments. A recommended list of candidates was developed which includes Raft River, East Mesa, Westmorland, Baca, Brawley, The Geysers and Roosevelt Hot Springs. Stimulation materials (fracture fluids, proppants, RA tracer chemicals, etc.) were screened for high temperature properties, and promising materials selected for further laboratory testing. Numerical models were developed to aid in predicting and evaluating stimulation experiments. (MHR)

25843 (DOE/AL/10563—T2) **Geothermal Reservoir Well Stimulation Project: reservoir selection task.** (Republic Geothermal, Inc., Santa Fe Springs, CA (USA)). Nov 1979. Contract AC32-79AL10563. 77p. NTIS, PC A05/MF A01.

The Geothermal Reservoir Well Stimulation Project has prepared a two-year program to develop and field test methods of stimulating geothermal wells. The program provides for six field experiments which progress in difficulty from low temperature reservoirs using current technology to high temperature reservoirs using advanced types of stimulation treatments. The process used to select the six field experiment locations and stimulation treatments is described. Tentatively, the following reservoirs are proposed: Raft River, East Mesa, Baca and Westmorland (two experiments), and Brawley and The Geysers or Roosevelt Hot Springs (two experiments). The program will be reviewed after each field treatment to select a specific well candidate for the next experiment and to determine whether alteration of the sequence will be beneficial to the overall success of the project and the geothermal industry.

25844 (LA—8343-MS, pp 2-16) **Stopping of a rising, liquid-filled crack in the earth's crust by a freely slipping horizontal joint.** Weertman, J. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

The water-filled cracks envisioned for use in the extraction of heat from hot dry rock masses are of dimensiona of the order of one or two kilometers. Will liquid-filled cracks of such large dimensions rise to the earth's surface. They certainly should if the critical stress intensity factor K/sub c/ of the crustal rock is within an order of magnitude or so of 3 MPa m/sup 1/2/, and if the cracks are in competent rock without pre-existing horizontal or near horizontal joints. But it is reasonable to expect any large rock mass to contain joints. Thus the possibility exists that any rising crack might be stopped by a joint and that much larger stable liquid-filled cracks can be created in a hot dry rock mass. This possibility is examined for the idealized case of a freely slipping horizontal joint. The more realistic case of a joint with friction is also considered. (The analysis is also applicable to the problem of a rising magma-filled crack as well as to the problem of a descending water-filled crack in a glacier). Although only vertical cracks and horizontal joints are considered, the results should be qualitatively correct for cracks that are only approximately vertical and joints that are only approximately horizontal. The results also should be qualitatively correct for cracks that do not extend an infinite distance in the third direction. (MHR)

25845 (LA—8343-MS, pp 17-25) **Characterization of a penny-shaped reservoir in hot dry rock.** Mura, T. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

In studying the feasibility of geothermal energy extraction, it is important to consider the stability of a reservoir. The thermoelastic effect should be taken into account in the study of the characterization of a reservoir. On the basis of fracture mechanics concepts extended to include thermoelastic effects, the present research deals with the characterization of a penny-shaped reservoir in the effective stage of operation of a geothermal energy system. The surrounding rock (granite) is assumed to be homogeneous and isotropic, and impermeable. After formulating the stable condition of a reservoir that is not changing its radius by propagation or closing, the flow rate necessary for a stable crack (critical flow rate) is plotted against the radius of the reservoir for various pressures of fluid (water) at the outlet on the earth's surface. The instability behavior of the reservoir is also studied when the inlet flow rate exceeds the critical value. It appears, that it is possible in jointed material to have vertical, stable liquid-filled cracks exist that have lengths that are much larger than those calculated for a liquid-filled crack in jointless rock. (MHR)

25846 (LA—8343-MS, pp 26-51) **Effects of temperature profile and anisotropy on instability of parallel thermal cracks in rock.** Bazant, Z.P.; Wahab, A.B. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

When a system of parallel equidistant cooling cracks propagates into half-space, it reaches at a certain depth a critical state at which the growth of every other crack is arrested. Later these cracks reach a second critical state at which they close. The intermediate cracks, at doubled spacing, open about twice as wide and advanced further as cooling penetrates deeper. Determination of the critical states requires calculation of the derivatives of the stress intensity factors with regard to crack lengths, which is here accomplished by finite element method. It is found that the crack depth-to-spacing ratio at which the critical state is reached is extremely sensitive to the temperature profile. This ratio greatly increases as the cooling front becomes steeper. The effect of transverse isotropy of the material upon the location of critical states is found to be relatively mild. The results are of interest for one recently proposed geothermal energy scheme for hot dry rock, as well as for shrinkage cracks in concrete.

25847 (LA—8343-MS, pp 52-113) **Thermally and hydraulically induced tension cracks.** Nemat-Nasser, S.; Keer, L.M. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

Research on thermally induced secondary cracks is summarized and the configuration of a system of penny-shaped cracks is examined. The following are included: initial crack spacing, crack rowth regime, methods of analysis, application to heat extraction from hot dry rock, derivation of basic equations, evaluation of physical quantities, growth and stability of coaxial penny-shaped cracks, and fracture opening by cooling. (MHR)

25848 (LA—8343-MS, pp 114-120) **Laboratory studies of hydraulic and thermal fracturing.** Dundurs, J. Feb 1980.

In Hot dry rock reservoir characterization and modeling. Progress report, October 1, 1978-September 30, 1979. Final report.

The laboratory experiments on hydraulic and thermal fracturing are done in transparent epoxy blocks. The blocks are cast from Shell Epon 828 resin with phthalic anhydrate hardener and cured, using a cooling program that is common for work in three-dimensional photoelasticity. Subsequently, the block faces are dressed flat and polished. The sizes used are either 150- or 200-mm cubes. Techniques have been developed for drilling and reaming deep 1.5-mm holes into the blocks, and cementing stainless steel tubing in the holes. The hydraulic fracturing is done with mercury by connecting the tubes to smaller plunger pumps and squeezing the fluid into either the initially precracked bottom of the hole, or simply the uncased bottom of the hole (typically 5 mm long). The pumps are motor driven and can be run at various speeds. (MHR)

25849 (LA-UR—80-454) **In situ heat transfer in man-made geothermal energy reservoirs.** Murphy, H.D.; Tester, J.W.; Grigsby, C.O.; Potter, R.M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 39p. (CONF-800723—17). NTIS, PC A03/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Two hot dry rock geothermal energy reservoirs were created by hydraulic fracturing of Precambrian granitic rock on the west flank of the Valles Caldera, a dormant volcanic complex, in the Jemez Mountains of northern New Mexico. Heat was extracted in a closed-loop mode of operation, injecting water into one well and extracting the heated water from a separate production well. The first reservoir was produced by fracturing the injection well at a depth of 2.75 km (9020 ft) where the indigenous rock temperature was 185°C. The relatively rapid thermal drawdown of the water produced from the first reservoir, 100°C in 74 days, indicated that its effective fracture radius was about 60 m (200 ft). Average thermal power extracted was 4 MW. A second, larger reservoir was created by refracturing the injection well 180 m (600 ft) deeper. Downhole measurements of the water temperature at the reservoir outlet as well as temperatures inferred from chemical geothermometry showed that the thermal drawdown of this reservoir was negligible; the effective heat transfer area of the new reservoir must be at least 45,000 m^2 (480,000 ft^2), nearly six times larger than the first reservoir. In addition reservoir residence time studies employing visible dye tracers indicated that the mean volume of the second reservoir is nine times larger. Other measurements showed that flow impedances were low, downhole water losses from these reservoirs should be manageable, that the geochemistry of the produced water was essentially benign, with no scaling problems apparent, and that the level of induced seismic activity was insignificantly small.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 25825

25850 (EGG—2036) **Fluidized-bed potato waste drying experiments at the Raft River Geothermal Test Site.** Cole, L.T.; Schmitt, R.C. (EG and G Idaho, Inc., Idaho Falls (USA)). Jun 1980. Contract AC07-76ID01570. 22p. NTIS, PC A02/MF A01.

A fluidized-bed dryer was built and operated at the Raft River Geothermal Test Site in south central Idaho to test the feasibility of using low-temperature (145°C or lower) geothermal fluids as an energy source for drying operations. The dryer performed successfully on two potato industry waste products that had a solid content of 5 to 13%. The dried product was removed as a sand-like granular material or as fines with a flour-like texture. Test results, observations, and design recommendations are presented. Also presented is an economic evaluation for commercial-scale drying plants using either geothermal low-temperature water or oil as a heat source.

GEOTHERMAL DATA AND THEORY

PROPERTIES OF AQUEOUS SOLUTIONS

25851 (COO—4896-T2) **Thermodynamic properties of pure and saline (geothermal) water.** Packer, M.B.; Mikic, B.B.; Meal, H.C.; Guillamon-Duch, H. (Massachusetts Inst. of Tech., Cambridge (USA). School of Engineering). Jan 1980. Contract ET-78-S-02-4896. 68p. NTIS, PC A04/MF A01.

In order to evaluate the performance of proposed processes utilizing geothermal energy, it is essential to determine the thermodynamic properties of fluid streams at various points in the system. The method described ascertains the values of these properties for either pure water or salt solution, correlating temperature, pressure, enthalpy, and entropy in the liquid, two-phase, and vapor regions. The corresponding FORTRAN computer formulation is coded in one subroutine and twenty-six function subprograms, sixteen of which represent correlations of the properties of pure water. The subroutine chooses the appropriate correlations, validates input data, and embodies a large fraction of the salt solution algorithms. Including nonexecutable comment lines, the entire formulation requires less than 910 lines of code. (MHR)

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 25844, 25845, 25846, 25847

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 26460

WAVE ENERGY CONVERTERS

REFER ALSO TO CITATION(S) 25644

WIND ENERGY

ECONOMICS

REFER ALSO TO CITATION(S) 25853

25852 (COO—4450-79/1) **Planning manual for utility application of WECS.** Park, G.L. (ed.). (Michigan State Univ., East Lansing (USA). Div. of Engineering Research). Jun 1979. Contract EG-77-S-02-4450. 245p. NTIS, PC A11/MF A01.

A two-part approach for evaluating the feasibility of wind electric conversion systems (WECS) for utility application is presented and explained. Assessment of wind energy potential, sites, interconnection, and capital and production costing is included. The first part is a brief preliminary procedure used to determine whether the expense and effort of a detailed investigation is justified. The preliminary procedure requires assumptions which limit its accuracy. If the result indicates that WECS have probable potential for a specific utility application, then a set of modifications to detailed conventional planning procedures is developed. The modifications include discussion of wind velocity estimation and effects of site features on wind velocity, institutional problems, siting, choosing generation cases with WECS, reliability considerations, production costing, and operating problems. Appendices include an annotated bibliography, wind measurement methods, procedure for estimating WECS capacity factor, and a method for generating correlated wind velocity samples for use in production cost programs.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

25853 (DOE/NASA/0002—80/2) **MOD-2 wind turbine system concept and preliminary design report. Volume 1. Executive summary.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). Jul 1979. Contract AI01-79ET20305. 32p. NTIS, PC A03/MF A01.

The MOD-2 configuration evolved from extensive trade studies and sensitivity studies coupled with inputs from NASA, several utilities, and with the results of a Failure Modes and Effects Analysis (FMEA). The resulting system is optimized for a minimum cost of electricity while maintaining compatibility with existing utility networks and while meeting safety requirements. A system life of 30 years with low annual operations and maintenance costs as well as low initial costs were coupled with performance optimization to establish the design which achieves the COE goal of less than 4 cents per KWH. The design approach is illustrated. The general arrangement and characteristics of the MOD-3 system are presented.

25854 (EPRI-AP—1317) **Large wind turbine generator performance assessment. Technology status report No. 1.** Vachon, W.A. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Jan 1980. 90p. NTIS, PC A05/MF A01.

The results of large wind turbine generator (WT) development and field test activities are presented. An approach for gathering, distilling, and assessing WT test data is presented, with emphasis on the usefulness of the data to the industry. Test results to date have validated the DOE/NASA WT design procedures which have been established by both supporting research and technology and sound engineering programs. These programs have employed first-generation, horizontal axis WT's in research and operation tests. Cost of energy (COE) procections indicate that later generation WT's are likely to provide electricity at competitive costs in some utility systems within several years. Several privately funded horizontal and vertical-axis WT's are presently either in the planning or construction phase, or actually under test in utility grids. Test results from these WT's will be presented in future reports.

25855 (SAND—78-0984) **Automatic-control system for the 17-metre vertical-axis wind turbine (VAWT).** McNerney, G.M. (New Mexico Univ., Albuquerque (USA). Civil Engineering Research Facility). Mar 1980. Contract EY-76-C-04-0789. 49p. Dep. NTIS, PC A03/MF A01.

The 17-metre DOE/Sandia VAWT began operation in March 1977. Since that time the turbine has been operated strictly by manual control for the purpose of data acquisition and performance analysis; this procedure has limited the VAWT operation time and power output. An automatic-control system has been designed and implemented to study automatic control of a VAWT and to better judge the fatigue life and reliability of the VAWT under what will be normal operating conditions for power production. This system, including the necessary hardware, is discussed in detail along with a simplified cost analysis.

25856 (SAND—80-0179) **Aerodynamic performance of a 5-metre-diameter Darrieus turbine with extruded aluminum NACA-0015 blades.** Sheldahl, R.E.; Klimas, P.C.; Feltz, L.V. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract EY-76-C-04-0789. 41p. Dep. NTIS, PC A03/MF A01.

A 5-metre-diameter vertical-axis wind turbine has undergone continued testing since 1976 at the Sandia Laboratories Wind Turbine site. The latest tests of this machine have been with extruded aluminum blades of NACA-0015 airfoil cross section. The results of these tests at several turbine rotational speeds are presented and compared with earlier test results. A performance comparison is made with a vortex/lifting line computational code. The performance of the turbine with the extruded blades met all expectations.

POWER CONVERSION SYSTEMS

25857 (COO—4450-79/2) **Impact of storm fronts on utilities with WECS arrays. Final report.** Schlueter, R.A.; Park, G.L.; Modir, H.; Dorsey, J.; Lotfallian, M. (Michigan State Univ., East Lansing (USA). Div. of Engineering Research). Oct 1979. Contract EG-77-S-02-4450. 149p. NTIS, PC A07/MF A01.

The effects of large rapid changes in generation from large arrays of wind turbine generators on the operation of automatic generation control and frequency regulation will be assessed. The maximum change and rates of change of generation from an array of wind turbines due to passage of a thunderstorm front is determined first. The assessment required (1) modeling an array of wind turbines in order to determine power variation for changes in wind speed caused by a storm front; (2) simulation of the model to determine

power variation from a worst case coastal farm due to passage of a front; and (3) analysis of the maximum change and rates of change from the portion of the array affected by the front.

SITE CHARACTERISTICS

25858 (RLO—2438-78/1) **Sites for wind-power installations: physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part I. Executive summary.** Meroney, R.N.; Sandborn, V.A. (Colorado State Univ., Fort Collins (USA). Dept. of Civil Engineering). Jun 1978. Contract EY-77-S-06-2438. 102p. NTIS, PC A06/MF A01.

Wind-tunnel model measurements have been performed to study the influence of topography profile, surface roughness and stratification on the suitability of various combinations of these variables for wind-power sites. For the range of examined cases (large turbulence integral scales with respect to surface feature scales) the flow is dominated by inviscid dynamics. Detailed tables of velocity, turbulence intensity, pressure, spectra, etc., have been prepared to guide numerical model design and experimental rule of thumb constrictions. Cases include hill slopes from 1:2 → 1:20, neutral and stratified flows, two- and three-dimensional symmetric ridges, six alternate hill and escarpment shapes, and a variety of windward versus leeward slope combinations to evaluate ridge separation characteristics.

25859 (RLO—2438-78/2) **Sites for wind-power installations: wind characteristics over ridges. Part II. Final report.** Bouwmeester, R.J.B.; Meroney, R.N.; Sandborn, V.A. (Colorado State Univ., Fort Collins (USA). Dept. of Civil Engineering). Jun 1978. Contract EY-77-S-06-2438. 122p. NTIS, PC A06/MF A01.

The purpose of this research was to increase knowledge of the physical processes that govern wind characteristics over ridges and, subsequently, to improve empirical and numerical for estimating wind velocities over ridges. These objectives were achieved by conducting a wind-tunnel study of the flow field over triangular-shaped and sinusoidal-shaped ridge models with varying upwind and downwind slopes under various thermal stratification conditions. A simple technique was developed to predict the velocity-amplification profile above a ridge crest for an arbitrary ridge slope. Largest speedups were measured for the steepest symmetrical ridge which did not cause flow separation. Criteria for flow separation over ridges are provided in this report. Applicability of the results for ridges with finite width is discussed.

25860 (RLO—2438-78/3) **Sites for wind power installations: physical modeling of the influence of hills ridges and complex terrain on wind speed and turbulence.** Meroney, R.N.; Sandborn, V.A. (Colorado State Univ., Fort Collins (USA). Dept. of Civil Engineering). Jun 1978. Contract EY-77-S-06-2438. 211p. NTIS, PC A10/MF A01.

A systematic wind-tunnel study of flow over two-dimensional hills was made. The flow over six different two-dimensional hills was evaluated for identical approach conditions. The results indicated that the triangular and sinusoidal hills produced the greatest speedup of the airstream in the region near the surface. The more abrupt models produced less of an increase in local velocity.

25861 (RLO—2443-77/1) **Summary of guidelines for siting wind turbine generators relative to small-scale, two-dimensional terrain features. Final report.** Frost, W.; Nowak, D.K. (FWG Associates, Inc., Tullahoma, TN (USA)). Mar 1979. Contract AC06-77ET20242. 395p. NTIS, PC A17/MF A01.

A summary of a detailed users' manual on siting wind turbine generators (WTG's) relative to small-scale, two-dimensional, terrain features is given. The terrain featrues considered are one or more surface roughness changes on otherwise flat terrain, shelterbelts or windbreaks, and bluff and smooth contoured hills. Estimates are given of the preferred WTG location relative to these terrain features and of the resulting degradation in available wind power due to locating the WTG other than at the preferred site. The siting criteria are based on fluid mechanics analyses of somewhat idealized terrain geometries and prevailing atmospheric conditions. Therefore, the results presented show trends and order of magnitude effects rather than absolute values. The theoretical approach to analyzing the flow field and the reliability of the analytical assumptions for each terrain feature considered are discussed in their respective sections.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 25123, 25599, 26069, 26079

25862 (CONS—8138-T4) **Analysis of costs and benefits for eight powerplant productivity improvement projects. Project 1, Task 3. Final report.** (Illinois Commerce Commission, Springfield (USA)). 8 Jun 1979. Contract FC01-77RG08138. 57p. NTIS, PC A04/MF A01.

In 1976, DOE (FEA) sponsored the development of a systematic methodology for the identification and analysis of candidate projects which a utility might undertake to improve baseload unit reliability. This methodology also enabled the user to estimate a project's effect on the future performance of the unit. A project was sponsored in Illinois to demonstrate the methodology and to encourage increased power plant productivity in the state. A total of 8 improvement projects were conducted and analyzed at Illinois Power Company Wood River 5 and Commonwealth Edison Company Quad Cities 1 and 2 units. A general description of the approach followed in estimating costs and benefits and in presenting the results for the 8 projects is provided. A brief technical description of the projects and their total cost, total benefits, net present value, and benefit-to-cost ratio is given. Detailed cost and benefit summaries for each project are presented followed by a discussion of the results.

25863 (NCEI—0010) **Wood-fueled electric generating station. Phase II. Detailed feasibility study.** (Sirrine (J.E.) Co., Research Triangle Park, NC (USA). North Carolina Div.). Dec 1979. 302p. NTIS.

The economic and environmental effects of constructing and operating a 10 MW wood-fueled power plant were studied to determine the feasibility of such a plant in the area served by the French Broad Electric Membership Corporation in North Carolina. Information is included on alternative power sources; description and drawings of the proposed plant; the economics of such power generation as compared with operation using conventional fossil fuels; the availability of wood fuel; site selection; and environmental effects and public acceptance. This study concluded that the proposed plant is technically feasible; wood fuel is in abundant supply in the area; such a plant is not only environmentally acceptable but desirable by comparison with alternatives; people in the area were favorably disposed to the plant being built; and although the construction costs per kW are high due to the small size of the pilot plant, the break even point in revenue versus generating costs would be 2 y if an REA, or other, grant were received for full capital costs and 10 years with no grant. It is recommended that the project should proceed to detailed environmental assessment and design leading to construction and initial operation in late 1982. (LCL)

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

25864 (EPRI-CS—1370) **Development and verification of laboratory model techniques for prediction of near-field behavior of cooling-tower plumes. Final report.** Jain, S.C.; Kennedy, J.F. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Mar 1980. 160p. NTIS, PC A09/MF A01.

The primary purpose of this study was to validate, by comparing corresponding model and prototype data, small-scale model testing of mechanical draft cooling towers as a reliable means of plume prediction. Tests were also conducted to investigate the effects of plume buoyancy and ambient (wind) velocity, and plant-building location on plume trajectories, tower recirculation, plume downwash, and plume merger. Modeling requirements and limitations are summarized. Small-scale models of two existing plants for which sufficient field data were available to permit meaningful comparison were tested in the Environmental Flow Facility (EFF) of the Iowa Institute of Hydraulic Research. The EFF is a recirculatig water flume with a working section 19.8-m long, 3-m wide, and 2.3-m deep. Laboratory testing techniques were developed and modified as needed to bring field and laboratory data into conformity. Particular attention was directed to the role of the velocity distribution in the boundary layer of approach flow; vortex generators and floor roughness were installed in the upstream section of the flume to produce a velocity distribution corresponding to the 1/6 power law. The boundaries of prototype visible plumes were delineated from laboratory data on the stack-effluent concentration distributions. The boundaries of the visible plumes obtained from the scale models were in satisfactory agreement with those obtained in the prototype.

25865 (EPRI-WS—78-151, pp 3.2-3.8) **EPRI perspectives.** Reynolds, J.Z. (Electric Power Research Inst., Palo Alto, CA). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

An overview of the EPRI perspective in the subject area of Cooling Systems Effects Subprogram is presented. Dr. John Z. Reynolds, Project Manager, provides a reference point and framework that clarifies the relationship of the first eight papers. (DAD)

POWER CYCLES

REFER ALSO TO CITATION(S) 25303, 25612, 25613, 25614, 25615

25866 (DOE/ET/12431—T1(Vol.1)) **Feasibility study: fuel cell cogeneration in a water pollution control facility. Final report.** (Gilbert/Commonwealth, Reading, PA (USA)). Feb 1980. Contract AC03-78ET12431. 151p. NTIS, PC A08/MF A01.

A conceptual design study was conducted to investigate the technical and economic feasibility of a cogeneration fuel cell power plant operating in a large water pollution control facility. In this particular application, the fuel cell power plant would use methane-rich digester gas from the water pollution control facility as a fuel feedstock to provide electrical and thermal energy. Several design configurations were evaluated. These configurations were comprised of combinations of options for locating the fuel cell power plant at the site, electrically connecting it with the water pollution control facility, using the rejected power plant heat, supplying fuel to the power plant, and for ownership and operation. A configuration was selected which met institutional/regulatory constraints and provided a net cost savings to the industry and the electric utility. The displacement of oil and coal resulting from the Bergen County Utilities Authority application was determined. A demonstration program based on the selected configuration was prepared to describe the scope of work, organization, schedules, and costs from preliminary design through actual tests and operation. The potential market for nationwide application of the concept was projected, along with the equivalent oil displacement resulting from estimated commercial application.

25867 (FE—2357-61) **PFB coal fired combined cycle development program. Annual report, July 1978-June 1979.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). May 1980. Contract EX-76-C-01-2357. 284p. NTIS, PC A13/MF A01.

The Coal Fired Combined Cycle (CFCC) is the unique powerplant concept developed under the leadership of the General Electric Company to provide a direct coal-burning gas turbine and steam turbine combined cycle powerplant. On the basis of previous studies and confirming work under this contract, General Electric continues to believe that the CFCC approach offers important advantages over alternate approaches: higher powerplant efficiency in the combustor temperature range of interest; reduced combustor/steam generator corrosion potential, due to low fluid-bed tube temperature (as contrasted to the air in tube cycle); and increased gas turbine bucket life from improved material protection systems. The objective of this program is to evaluate the coal fired combined cycle powerplant conceptual design, and to conduct a supporting development program. The supporting development is required for evaluating the pressurized fluidized bed combustion concept, for developing engineering correlations to be used in optimizing the commercial plant concept, and for evaluating the combustor/steam generator, the hot-gas cleanup, and the advanced gas turbine materials approach for this application. Work to date has identified the need to protect the gas turbine from corrosion caused by substantial amounts of alkali in the submicron aerosol and vapor phase and to protect the turbine from erosion caused by multi-micron-sized particulates. We believe that a solution to the corrosion protection challenge can more confidently and quickly be found by extending turbine materials work in dirty liquid fuels to the PFB environmental levels. Particulate removal for erosion protection has as its objective a better quantification of the erosion tolerance level coupled with work to improve the performance of inertial separators, including electrostatic augmentation, in the less-than-10-μm-particle-size region. A few other testing programs are described briefly.

25868 (FE—2357-71) **PFB coal fired combined cycle development program. Commercial plant requirements definition update (Task 1.1).** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). May 1980. Contract EX-76-C-01-2357. 134p. NTIS, PC A07/MF A01.

The Coal Fired Combined Cycle (CFCC) power system thermodynamic cycle is illustrated schematically. Pressurized air supplied at the discharge of gas turbine compressors is ducted to the pressure vessel of pressurized, fluidized-bed, combustor-steam generator modules. The air is introduced in parallel to the beds, entering through distribution grids beneath each bed. Steam generation tubes are buried within the beds and are also arranged as membrane tube walls enclosing the four sides. Crushed coal (1/4 inch x 0) is pneumatically fed at locations just above the air inlet grids at the bottom of each bed. Dolomite is similarly fed to the individual beds. The coal is burned at a temperature below the ash fusion point. Sulfur is removed in the fluid beds through reaction of the SO_2 with $CaCO_3$ and O_2 to form solid $CaSO_4$ and CO_2 gas. The combustion gases leave the beds at a temperature in the range of 1400°F to 1750°F, depending upon the plant load fraction, and combustion heat is also transferred from the bed to the steam generation tubes. For the PFB combustor at full load, approximately 39% of the heating value of the coal appears i the exhaust gas, 57% appears in the steam, and 4% is apportioned among various losses. The steam circuitry is the supercritical once-through type. Steam is generated at 3500 psi and 1000°F and is reheated to 1000°F after expansion through the high pressure section of the steam turbine. The exhaust gases from the fluidized beds, which entrain a high percentage of the coal ash as well as dolomite fines, are ducted to conventional cyclones and then to electrocyclones before being admitted to the gas turbine.

COMPONENTS

REFER ALSO TO CITATION(S) 26268

25869 (FE—2465-12) **Erosion study in turbomachinery affected by coal and ash particles. Annual progress report, November 1, 1978-December 31, 1979.** Tabakoff, W.; Hamed, A.; Ramachandran, J.; Kotwal, R.; Beacher, B. (Cincinnati Univ., OH (USA). Dept. of Aerospace Engineering and Applied Mechanics). Feb 1980. Contract EX-76-C-01-2465. 117p. NTIS, PC A06/MF A01.

Three alloys were tested in the test facility which has been designed to simulate the aerodynamic and thermodynamic conditions in the turbine. The effects on erosion due to the high tempeature coal ash gas stream was determined at several gas temperatures, particle velocities and angles of attack. The test results for 304 stainless steel, Rene 41 and A286, and the corresponding conclusions are presented. In addition, a series of experiments were conducted to determine the effects of fly ash constituents on the erosion of iron and nickel base alloys. A new semi-empirical equation has been obtained for the prediction of metal erosion due to the fly ash.

25870 (ORO—5779-T1) **Development and field demonstration of a controlled cavitation erosion (CONCAVER) descaling system for industrial boiler tubes.** Koogle, D.R.; Bohli, W.H.; Thiruvengadam, A.P.; Hochrein, A.A. Jr. (Daedalean Associates, Inc., Woodbine, MD (USA)). Aug 1979. Contract ET-78-C-05-5779. 71p. NTIS, PC A04/MF A01.

The design, operation and performance of the CONCAVER, a device which uses high pressure water ejected from a rotating or stationary nozzle to clean and descale the inside of industrial boiler tubes, are discussed in detail. This descaler and its associated equipment has been field tested. The results showed that 8000 psi pressure is required to remove scale from the boiler tubes, rotating nozzles result in the best cleaning of tubes with greater than 1 1/2 in.-dia. and the cleaning time is 40% faster than with conventional cleaning methods. (LCL) a

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 25980

25871 (CONF-791232—, pp 79-84) **Conceptual design of thermal energy storage systems for near-term electric utility applications.** Hall, E.W. (General Electric Co., Schenectady, NY). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The goals of this project are to: identify, design, and evaluate promising thermal energy storage systems for mid-term applications in conventional electric utilities for peaking power generation; evaluate candidate thermal energy storage systems and select the most promising concepts; complete conceptual designs of selected thermal energy storage systems integrated with conventional utilities; define characteristics of alternate systems for peaking power generation, viz gas turbines and coal fired cycling plants; perform competitive benefit analysis of thermal energy storage systems with alternate systems for peaking power generation; and make recommendations for development and field test of thermal energy storage with a conventional utility. The results showed that thermal energy storage was only marginally competitive with coal fired cycling power plants and gas turbines for peaking power generation. A development and field test program does not appear viable to utilities at the present time.

25872 (DOE/ET/15445—T1) **Rankine bottoming cycle safety analysis. Final report.** Lewandowski, G.A. (Vector Engineering, Inc., Springfield, NJ (USA)). Feb 1980. Contract AC05-79ET15445. 100p. NTIS, PC A05/MF A01.

Vector Engineering Inc. conducted a safety and hazards analysis of three Rankine Bottoming Cycle Systems in public utility applications: a Thermo Electron system using Fluorinal-85 (a mixture of 85 mole % trifluoroethanol and 15 mole % water) as the working fluid; a Sundstrand system using toluene as the working fluid; and a Mechanical Technology system using steam and Freon-II as the working fluids. The properties of the working fluids considered are flammability, toxicity, and degradation, and the risks to both plant workers and the community at large are analyzed.

ECONOMICS

REFER ALSO TO CITATION(S) 25254, 25999, 26000, 26001

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 25871

FUELS

REFER ALSO TO CITATION(S) 25129, 25260, 25263, 26243

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25863, 26328, 26338, 26342, 26343, 26345, 26427, 26429, 26430, 26431, 26432, 26438

25873 (EPRI-WS—78-151, pp 3.9-3.17) **Review of ecosystem effects of phytoplankton and zooplankton entrainment .** Alevras, R.A. (Lawler, Matusky and Skelly Engineers, Pearl River, NY). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The results of a Lawler, Matusky, and Skelly (LMS) review of the literature on the effects of power plant entrainment on phytoplankton and zooplankton are summarized. Results of studies reported in utility company documents were emphasized. A broad geographic coverage was attempted with power plants categorized into lacustrine, riverine, estuarine, and marine environments. The objective was to attempt a definitive documentation and assessment of ecosystem effects. (DAD)

25874 (EPRI-WS—78-151, pp 3.19-3.21) **Methodology for assessing population and ecosystem level effects related to intake of cooling water .** Alevras, R.A. (Lawler, Matusky and Skelly Engineers, Pearl River, NY). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A quantitative methodology for assessing population and ecosystem effects resulting from impingement and entrainment of major fish and invertebrate species was developed. Latent or sublethal effects were not discussed. The application of the methodology to power plant sites in lacustrine, riverine, estuarine, and marine environments was demonstrated. (DAD)

25875 (EPRI-WS—78-151, pp 3.85-3.93) **Development of an information resource on cooling system effects.** Hannon, E.H. (Atomic Industrial Forum, Inc., Washington, DC); Talmage, S. Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The status of a Cooling Systems Data Base that contains more than 7000 references and abstracts is discussed. The data base is located at the Atomic Industrial Forum's (AIF) INFORUM project in Washington, DC and at the Information Center Complex at Oak Ridge National Laboratory (ORNL), Oak Ridge, TN. Data bases from both groups were to be combined into a joint cooling systems data base. (DAD)

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 25865, 26434

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 25133, 25219, 25224, 26344, 26345, 26428, 26433

25876 (DOE/METC/8333—11) **Workshop on sulfur chemistry in flue gas desulfurization.** Wallace, W.E. Jr. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). May 1980. Contract AT21-78MC08333. 253p. (CONF-7906165—). NTIS, PC A12/MF A01.

From Flue gas desulfurization workshop; Morgantown, WV, USA (7 Jun 1979).

The Flue Gas Desulfurization Workshop was held at Morgantown, West Virginia, June 7-8, 1979. The presentations dealt with the chemistry of sulfur and calcium compounds in scrubbers. DOE and EPRI programs in this area are described. Ten papers have been entered individually into EDB and ERA. (LTN)

25877 (EPRI-CS—1372) **Feasibility of retrofitting catalytic post-combustion NO/sub x/ controls on an 80-MW coal-fired utility boiler. Final report.** Swann, D.R.; Drissel, G.D. (Stearns-Roger Corp., Denver, CO (USA)). Feb 1980. 231p. NTIS, PC A11/MF A01.

Although reports of pilot studies in Japan have encouraged the viewpoint that reliable postcombustion NO/sub x/ control processes are presently available, the practical problems and costs associated with application to full-scale systems have not been adequately addressed. The purpose of this project was to assess the technical feasibility, engineering and construction requirements, operational limitations, and costs for retrofitting an SCR system on an 80-MW utility boiler. The retrofit installation of postcombustion NO/sub x/ controls appears to be mechanically feasible. The space and utility requirements normally available at an existing plant will not be restrictive, although major equipment items such as the air preheater and fans will probably need to be relocated. Engineering assessment and cost estimates were performed for processes offered by two leading Japanese manufacturers. The total capital requirement for the retrofit installation ranged from 61 to 72 dollars per kilowatt. Approximately three-fourths of this cost is for yearly replacement of the catalyst. This study has identified and examined many technical uncertainties that must be resolved before feasibility is assured and large commercial installations can be justified. Potential problems include the fouling and corrosive effects of NH_3 byproducts, the catalytic conversion of sulfur dioxide to sulfur trioxide, and boiler performance and operational penalties. The majority of these issues are generic to the SCR process and do not result from individual manufacturer designs or catalyst composition. These issues will be specifically examined during 1980 in the 2.5-MW pilot SCR facility constructed under EPRI contract at the Arapahoe Test Facility in Denver, Colorado.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 25882, 25980, 26346

25878 Regional screening procedure for land use suitability analysis. Dobson, J.E. (Oak Ridge National Lab., TN). *Geogr. Rev.;* **69**: No. 2, 1-11(Apr 1979).

Increasing opposition to proposed energy facilities and regulatory delays in licensing have created a pressing need for a comprehensive and objective method to select potential sites. This paper discusses the results of a research project designed to develop and apply an automated regional screening procedure to identify the land use suitability of every land parcel within any candidate region. Although the current project involves energy facilities, the procedure itself should have general capabilities of application to other types of facilities and land uses. It is intended that siting criteria for any particular land use may be examined from the standpoint of several independent siting objecties. The ones examined in this project emphasize engineering, ecological, and socioeconomic considerations. This paper describes, first, the requirments of a regional screening procedure and, second, an applicaton of the Land Use Screening Procedure (LUSP) to northern Maryland. The application is structured to determine the types of siting issues that LUSP is capable of addressing and the extent to which it can be used to identify candidate areas (large areas from which specific sites can be chosen after highly detailed analyses).

POWER TRANSMISSION AND DISTRIBUTION

25879 (AD-A—077411/7) **Field excitation of multiconductor transmission lines. Final report.** Tesche, F.M.; Liu, T.K.; Giri, D.V.; Chang, S.K. (Science Applications, Inc., Berkeley, CA (USA)). Feb 1979. Contract F29601-78-C-0002. 45p. NTIS, PC A03/MF A01.

This report discusses the excitation of a multiconductor transmission line by an incident electromagnetic field. Specific relations for the terminal (or load) response of a multiconductor line are derived in terms of field-induced voltage and current sources which are distributed along the transmission line. It is shown how these sources are derived for a general multiconductor line and how they may be derived from a knowledge of the incident (or free space) fields by using a field coupling parameter. The components of the exciting fields along the line are then given explicitly for the special case of an incident plane wave with arbitrary angle of incidence.

25880 (AD-A—077659/1) **The EMP response of a system of uncoupled, interconnected cables. Technical report.** Gray, R.F. (Harry Diamond Labs., Washington, DC (USA)). Oct 1979. 20p. NTIS, PC A02/MF A01.

An approximate analytical technique is developed for the electromagnetic pulse (EMP) response of a complex system of cables deployed over a real earth. The technique involves an existing transmission-line solution for the EMP response of a cable which is extended to a system of interconnected but uncoupled cables by the principle of superposition. The complete response of one particular cable is found by replacing all the other cables connected to it with equivalent Thevenin sources. The response of the cable due to the EMP and the equivalent sources are then summed. The equivalent Thevenin sources are developed from the existing transmission-line

solution for the EMP response of a single cable. Experimental verification of the applicability of the superposition principle to transmission lines is also given.

AC SYSTEMS, EHV AND UHV

25881 (COO—4830-3) **Development of advanced methods for planning electric energy distribution systems. Final report.** Goenen, T.; Foote, B.L.; Thompson, J.C.; Fagan, J.E. (Oklahoma Univ., Norman (USA). School of Industrial Engineering). Oct 1979. Contract EM-78-S-02-4830. 165p. NTIS, PC A08/MF A01.

Portions of this report are illegible.

An extensive search was made for the identification and collection of reports published in the open literature which describes distribution planning methods and techniques. In addition, a questionnaire has been prepared and sent to a large number of electric power utility companies. A large number of these companies were visited and/or their distribution planners interviewed for the identification and description of distribution system planning methods and techniques used by these electric power utility companies and other commercial entities. Distribution systems planning models were reviewed and a set of new mixed-integer programming models were developed for the optimal expansion of the distribution systems. The models help the planner to select: (1) optimum substation locations; (2) optimum substation expansions; (3) optimum substation transformer sizes; (4) optimum load transfers between substations; (5) optimum feeder routes and sizes subject to a set of specified constraints. The models permit following existing right-of-ways and avoid areas where feeders and substations cannot be constructed. The results of computer runs were analyzed for adequacy in serving projected loads within regulation limits for both normal and emergency operation.

25882 (DOE/EIS—0067(D)) **Environmental impact statement (Draft). 230 kV international transmission line, San Diego County, California to Tijuana, Mexico, San Diego Gas and Electric Company.** (Department of Energy, Washington, DC (USA); California Public Utilities Commission, San Francisco (USA)). May 1980. 112p. Department of Energy, Office of Utility Systems, Washington, DC.

This draft environmental impact statement (DEIS) was prepared jointly by the Economic Regulatory Administration (ERA) and the California Public Utilities Commission (CPUC). The proposed action by the Department of Energy is the granting of a Presidential Permit for the construction, connection, operation, and maintenance of 10 miles of a 230-kV transmission line from Miguel Substation to the international border. The proposed project will connect the San Diego Gas and Electric (SDG and E) system with that of the Comision Federal de Electricidad (CFE) for the purpose of economic exchanges of power and increasing reliability. Major impacts will be visual changes, US Border Patrol aviation safety, disturbance of rare and endangered plant species and cultural resources.

DC SYSTEMS

REFER ALSO TO CITATION(S) 25883, 25884

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

25883 (LA-UR—80-125) **Wave propagation in a dc superconducting cable, Part I: analysis.** Chowdhuri, P.; Mahaffy, M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 9p. (CONF-800722—1). NTIS, PC A02/MF A01.

From IEEE PES summer meeting; Minneapolis, MN, USA (Jul 1980).

A dc superconducting cable design consisting of four concentric metallic cylinders, of which two carry the load current and two comprise the cryogenic enclosure, is considered. When a transient voltage is impressed across such a cable, the major dielectric may not be fully stressed to its design value, and unwanted voltage stresses may develop across other parts of the cable. The surge-voltage propagation characteristics of a four-conductor dc superconducting cable for a step-function input voltage is analyzed. This analysis, although mainly directed to superconducting cables, is also applicable to other multiconductor transmission lines. A companion paper discusses the parametric effects of the cable system in optimizing the voltage distribution.

25884 (LA-UR—80-126) **Wave propagation in a dc superconducting cable, Part II: parametric effects.** Chowdhuri, P.; Mahaffy, M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 9p. (CONF-800722—2). NTIS, PC A02/MF A01.

From IEEE PES summer meeting; Minneapolis, MN, USA (Jul 1980).

Wave propagation in several design of dc superconducting cables are studied. DC conventional cables are also included for the purpose of comparison. For a multiconductor cable system, undesirable transient voltages may develop across parts that are not designed to withstand high voltages. The effects of several parameters were studied to limit these voltages; these are voltage rating, number of conductors, conductor resistances, earth resistivity, terminal grounding resistances of the grounded conductors at the origin and dielectric constants. Voltage rating, conductor resistances, and terminal grounding resistances seem to influence the transient performance of a multiconductor cable significantly. The effect of finite earth resistivity is insignificant.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 25977

25885 (DOE/PE—0014/R1) **First annual report on nuclear nonproliferation: supplement to annual report to Congress.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Policy and Evaluation). 1979. 38p. NTIS, PC A03/MF A01.

Section 602 of the Nuclear Non-Proliferation Act of 1978 (NNPA) requires that DOE's Annual Report include views and recommendations regarding non-proliferation policies and actions for which the Department is responsible. The Act also requires a detailed analysis of the proliferation implications of advanced enrichment and reprocessing techniques, advanced reactors, and alternative fuel cycles, including an unclassified summary and a comprehensive version containing relevant classified information. The goals of United States non-proliferation policy are to minimize the spread of nuclear weapons and to create a stable international environment for the peaceful use of nuclear energy.

25886 (ORAU/IEA—80-6(M)) **Public attitudes and information on the nuclear option.** Firebaugh, M.W. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). May 1980. Contract AC05-76OR00033. 28p. NTIS, PC A03/MF A01.

A summary of the principal findings of public opinion surveys on nuclear energy is presented. Attitudes polled include those on building more plants, a nuclear moratorium, options for reducing risks, questions of safety and cost advantage, and the most trusted sources of information about nuclear energy. Next, some less empirical observations for interpreting these results are presented. These address the inertia of beliefs, nature of risk perception, symbolic aspects of nuclear energy, and feasibility of nuclear education programs. Finally, several suggestions for public information programs based on the previously noted findings and observations are made. These include a safety program analogous to fire drills, itemized electrical bills, nuclear site media workshops, and suggestions for improved communication on nuclear issues.

25887 **Centers offer nuclear-power facts.** Metz, W.C. (Brookhaven National Lab., Upton, NY). *Electr. World;* **193**: No. 4, 52-55(15 Feb 1980).

Nuclear information centers can be a useful and educational adjunct for nuclear plant owners in promoting public acceptance of nuclear generation as viable and necessary to conventional plants. At 22 sites in 10 eastern states, there are 16 of these centers that vary markedly in the simplicity and complexity of their exhibits, displays, and demonstrations. Some utilities have shied away from opening such centers for a variety of reasons - not all of which may be logical. The types and numbers of public visitors to these facilities, on annual basis, range as widely and as diversely as the centers.

25888 **Maturity and future of nuclear energy.** Weinberg, A.M. (Oak Ridge Associated Universities, TN). pp 79-89 of Energy and physics. Petit-Lancy, Switzerland; European Physical Society (1976).

From 3. conference of the European Physical Society; Bucharest, Romania (9 Sep 1975).

The development of nuclear power plants is reviewed. Safety aspects, economics, and projected expansion of nuclear power are discussed.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 25383, 25911

25889 (ALO—76/1) **Nonlinear analysis of LWR components: areas of investigation/benefits/recommendations.** Brown, S.J. (ed.). (O'Donnell and Associates, Inc., Pittsburgh, PA (USA)). Apr 1980. Contract AC04-76DP00789. 210p. (ODAI—1350-2-79). NTIS, PC A10/MF A01.

The purpose of this study is to identify specific topics of investigation into design procedures, design concepts, methods of

analysis, testing practices, and standards which are characterized by nonlinear behavior (both geometric and material) and which are considered to offer some economic and/or technical benefits to the LWR industry (excluding piping). In this study these topics were collected, compiled, and subjectively evaluated as to their potential benefit. The topics considered to have the greatest benefit/impact potential are discussed. The topics of investigation were found to fall basically into three areas: component, code interpretation, and load/failure mechanism. The topics are arbitrarily reorganized into six areas of investigation: Fracture, Fatigue, Vibration/Dynamic/Seismic, Plasticity, Component/Computational Considerations, and Code Interpretation.

25890 (ALO—76/2) **Nonlinear analysis of LWR components: areas of investigation/benefits/recommendations.** Brown, S.J. (ed.). (O'Donnell and Associates, Inc., Pittsburgh, PA (USA)). Apr 1980. Contract AC04-76DP00789. 105p. (ODAI—2350-2-79). NTIS, PC A06/MF A01.

The purpose of this study is to identify specific topics of investigation into design procedures, design concepts, methods of analysis, testing practices, and standards which are characterized by nonlinear behavior (both geometric and material) and which are considered to offer some economic and/or technical benefits to the LWR industry (excluding piping). In this study these topics were collected, compiled, and subjectively evaluated as to their potential benefit. The topics considered to have the greatest benefit/impact potential are discussed. The topics listed are based upon the experience of ODAI and also based upon a sampling of over 100 engineers/scientists in the LWR industry. The topics of investigation were found to fall basically into three areas: component, code interpretation, and load/failure mechanism. The topics are arbitrarily reorganized into six areas of investigation: Fracture, Fatigue, Vibration/Dynamic/Seismic, Plasticity, Component/Computational Considerations, and Code Interpretation.

25891 (ALO—78) **Component failures that lead to reactor scrams.** Burns, E.T.; Wilson, R.J.; Lim, E.Y. (Science Applications, Inc., Palo Alto, CA (USA)). Apr 1980. Contract AC04-76DP00789. 116p. (SAI—154-79-PA). NTIS, PC A06/MF A01.

This report summarizes the operating experience scram data compiled from 35 operating US light water reactors (LWRs) to identify the principal components/systems related to reactor scrams. The data base utilized to identify the scram causes is developed from a EPRI-utility sponsored survey conducted by SAI coupled with recent data from the USNRC Gray Books. The reactor population considered in this evaluation is limited to 23 PWRs and 12 BWRs because of the limited scope of the program. The population includes all the US NSSS vendors. It is judged that this population accurately characterizes the component-related scrams in LWRs over the first 10 years of plant operation.

25892 (ALO—79) **Component failures that lead to manual shutdowns.** (Science Applications, Inc., Palo Alto, CA (USA)). 1979. Contract AC04-76DP00789. 67p. (SAI—180-80-PA). NTIS, PC A04/MF A01.

The data for this report are taken from a population of thirty-five LWRs, al of which differ appreciably in size, design, and age. Appendix A provides a graphical display of the number of manual shutdowns per operating year as a function of plant age, with the frequency adjusted to reflect plant availability.

25893 (UCID—18661) **Preliminary planning study for safety relief valve experiments in a Mark III BWR pressure suppression system.** McCauley, E.W.; Holman, G.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Apr 1980. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01.

In response to a request from the Water Reactor Safety Research Division of the US NRC, a preliminary study is provided which identifies key features and consideration involved in planning a comprehensive in-plant Safety Relief Valve experimental program for a Mark III containment design. The report provides identification of program objectives, measurement system requirements, and some details quantifying expected system response. In addition, a preliminary test matrix is outlined which involves a supporting philosophy intended to enhance the usefulness of the experimental results for all members of the program team: experimentalists, analysts, and plant operator.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 25383, 25889, 25890, 25891, 25892, 25901, 25911, 26268

25894 (DOE/TIC—11194) **Optimization of in-situ plutonium utilization in a PWR. Final report, 1 October 1978-29 September 1979.** Matchick, D.A.; Witzig, W.F. (Pennsylvania State Univ., University Park (USA). Dept. of Nuclear Engineering). 1979. Contract ET-78-S-01-3405. 2p. NTIS, PC A02/MF A01.

In order to investigate plutonium utilization in pressurized water reactors, an accurate, spatially explicit computational method is required. Presently available nuclear analysis codes do not meet these criteria. The XSDRN-BURN program was developed to provide the facility of a spatial representation of plutonium fuel utilization for differing core geometries. To this end, the XSDRN computer program was obtained from the Oak Ridge Radiation Shielding Information Center and modified under the study contract.

25895 (HEDL-TME—79-68) **Data report for the nondestructive examination of Turkey Point spent fuel assemblies B02, B03, B17, B41, and B43.** Davis, R.B. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract EY-76-C-14-2170. 130p. NTIS, PC A07/MF A01.

The fuel assembly sip test on all rods from assembly B17 were of sound intergrity. Visual examination showed three general regions of rod surface appearance: a dark adherent crud layer at the bottom of the rod, black spalling crud layers in the middle, and a spotty gray loose powdery coating with dark crud or oxide underneath towards the top. Rod lengths varied from 152.395 inches to 152.707 inches. Maximum rod bow measurements for rods G9, I9, and G7 were 0.038 to 040 inch and 0.022 inch for rods H6 and J8. Results from profilometry scans showed the maximum ovality for the five rods was 0.0066 inch with average diameters ranging from 0.4187 to 0.4198 inch. Extensive ridging from pellet-clad interaction over the entire length was evident on all rods. Gamma scan results showed no cesium peaking and no pellet gaps greater than 0.025 inch. No unusual areas, other than ridging and possible fuel-cladding bonding, were seen in the eddy current results.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 25350, 26115, 26134, 26135

25896 (COO—4057-4(Vol.2)) **Gas reactor international cooperative program. Interim report: assessment of gas-cooled reactor economics.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Aug 1979. Contract EN-77-C-02-4057. 387p. NTIS, PC A08/MF A01.

A computer analysis of domestic economic incentive is presented. Included are the sample computer data set for ten combinations of reprocessing and reactor assumptions; basic data set and computer output; higher uranium availability computer output; 50 percent higher GCR fabrication cost computer output; 50 percent higher GCR reprocessing cost computer output; year 1990 and year 2000 GCR introduction scenario computer outputs; 75 percent perceived capacity factor for PBR computer output; and capital cost of GCRs 1.2 times that of LWRs.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 25907, 25909, 25912, 25913, 26088, 26273

25897 (HEDL-SA—2066-FP) **Thermoelastic buckling of plates in a cylindrical geometry against an elastic back support.** Simmons, L.D.; Wierman, R.W. (Hanford Engineering Development Lab., Richland, WA (USA)). 1980. Contract EY-76-C-14-2170. 16p. (CONF-800360—1). NTIS, PC A02/MF A01.

From International conference on thermal stresses in materials and structures in severe thermal environments; Blacksburg, VA, USA (19 Mar 1980).

A plate which is fixed at its edges to a strong edge support structure will develop large compressive stresses when heated from ambient temperature more rapidly than the support structure. Determining the response of the plate to this situation requires stability analysis to ascertain whether the plate might buckle, or whether the constrained thermal expansion will lead to compressive stresses exceeding the yield point because it did not buckle. A special case is considered here, both analytically and experimentally, in which the plate is curved slightly into a cylindrical shape and the convex face of the plate is against a supporting surface. This case is more complex because the buckling mode will be a harmonic rather than the fundamental mode which is usually encountered.

25898 (ORNL/TM—7208) **Feasibility evaluation of x-ray imaging for measurement of fuel rod bowing in CFTL test bundles.** Baker,

S.P. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01.

The Core Flow Test Loop (CFTL) is a high temperature, high pressure, out-of-reactor helium-circulating system. It is designed for detailed study of the thermomechanical performance, at prototypic steady-state and transient operating conditions, of electrically heated rods that simulate segments of core assemblies in the Gas-Cooled Fast Breeder reactor demonstration plant. Results are presented of a feasibility evaluation of x-ray imaging for making measurements of the displacement (bowing) of fuel rods in CFTL test bundles containing electrically heated rods. A mock-up of a representative CFTL test section consisting of a test bundle and associated piping was fabricated to assist in this evaluation.

25899 (SAND—79-1366) **Thermal evaluation facility for LMFBR spent fuel transport.** Wesley, D.A. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 107p. NTIS, PC A06/MF A01.

A full-scale mock-up of a 217 pin breeder reactor fuel assembly in a cylindrical pipe was initially designed and constructed by Oak Ridge National Laboratory (ORNL). It was transferred to Sandia where it was extensively redesigned and modified. The 217 pin hexagonal core assembly was installed in a smaller diameter stainless steel pipe which more closely represents the diameter of a shipping canister or shipping cask basket wall. Two-hundred four of the tubes are electrically heated over an active length of 4-feet and the remaining thirteen are instrumented with multiple junction thermocouples which can be traversed axially. Thermocouples and heat-flux gauges are located on the hex core and canister perimeters at several axial locations.

25900 (PNL-TR—400) **Review of the development of fast breeder reactors in the USSR.** Kochetkov, L.A.; Bagdasarov, Yu.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 21 Apr 1980. Translation source information not available. 12p. Dep. NTIS, PC A02/MF A01.

Information on fast breeder reactors in the USSR is presented concerning the BR-5 (BR-10) reactor; BOR-60 reactor; BFS-2 test rig; BN-350 reactor; BN-600 reactor; and BN-1600 reactor.

ECONOMICS

REFER ALSO TO CITATION(S) 25279, 25896, 25975

FUEL CYCLE

25901 **Plutonium fuel cycles in the spectral shift controlled reactor.** Sider, F.M.; Matzie, R.A. (Combustion Engineering, Inc., Windsor, CT). *Nucl. Technol.;* **47**: No. 3, 444-450(Mar 1980).

The spectral shift controlled reactor (SSCR) controls excess core reactivity during an operating cycle through the use of variable heavy water concentrations in the moderator. With heavy water in the coolant, the neutron spectrum is shifted to higher energy levels, thus increasing fertile conversion. In addition, since heavy water obviates the need for soluble boron, neutron losses to control poison are eliminated. As a result, better resource utilization is obtained in the SSCR employing plutonium fuel cycles compared to similarly fueled pressurized water reactors (PWRs). The SSCR, however, is not competitive with the PWR due to higher capital costs, operation and maintenance costs, and the heavy water costs, which outweigh the fuel cycle cost savings. The SSCR may become an attractive alternative to the PWR if uranium prices increase substantially.

25902 **Uncertainty analysis and thermal stored energy calculations in nuclear fuel rods.** Cunningham, M.E.; Hann, C.R.; Olsen, A.R. (Battelle-Pacific Northwest Labs., Richland, WA). *Nucl. Technol.;* **47**: No. 3, 457-467(Mar 1980).

With the increasing sophistication and use of computer codes in the nuclear industry, there is a growing awareness of the need to identify and quantify the uncertainties of these codes. Work is now being performed at Battelle-Pacific Northwest Laboratories to study the uncertainties in steady-state stored energy calculations by using linear propagation of uncertainties. This method predicts the uncertainty of variables by propagating input variances through models. Comparison of Monte Carlo analysis to linear propagation shows good agreement and verifies the adequacy of linear propagation. Linear power, radial gap width, fuel thermal conductivity, flux depression, and fuel heat capacity are all shown to be parameters of major importance when calculating both stored energy and its uncertainty. The uncertainty for stored energy at beginning-of-life is ~ 17% (99% confidence level) and rises to a maximum of 37% during a simulated two-cycle power history.

25903 **Alternative nuclear fuel cycles.** Till, C.E. *Energy Technol. (Wash., D.C.);* **6**: 846-850(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

This diffuse subject involves value judgments that are political as well as technical, and is best understood in that context. The four questions raised here, however, are mostly from the technical viewpoints: (1) what are alternative nuclear fuel cycles; (2) what generalizations are possible about their characteristics; (3) what are the major practical considerations; and (4) what is the present situation and what can be said about the outlook for the future.

NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 25977

THEORY AND CALCULATION

25904 (LA-UR—80-1158) **Status of Monte Carlo at Los Alamos.** Thompson, W.L.; Cashwell, E.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 17p. (CONF-800471—3). NTIS, PC A02/MF A01.

From Seminar on theory and applications of Monte Carlo methods; Oak Ridge, TN, USA (Apr 1980).

At Los Alamos the early work of Fermi, von Neumann, and Ulam has been developed and supplemented by many followers, notably Cashwell and Everett, and the main product today is the continuous-energy, general-purpose, generalized-geometry, time-dependent, coupled neutron-photon transport code called MCNP. The Los Alamos Monte Carlo research and development effort is concentrated in Group X-6. MCNP treats an arbitrary three-dimensional configuration of arbitrary materials in geometric cells bounded by first- and second-degree surfaces and some fourth-degree surfaces (elliptical tori). Monte Carlo has evolved into perhaps the main method for radiation transport calculations at Los Alamos. MCNP is used in every technical division at the Laboratory by over 130 users about 600 times a month accounting for nearly 200 hours of CDC-7600 time.

25905 (ORNL/CSD/TM—116) **D0S perturbation modules DGRAD/VIP/TPERT.** Tomlinson, E.T.; Childs, R.L.; Lillie, R.A. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). May 1980. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A$6.30/MF $3.50.

The perturbation modules DGRAD, VIP, and TPERT have been upgraded to run under the D0S DRIVER. A brief discussion of each module, its function, and its input requirements is presented. One transport theory and one diffusion theory sample problem are also presented.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 25865, 26457

FUEL ELEMENTS

25906 (DOE/TIC—11201) **US recommended slow overpower transient ramp rate for PFR-TREAT test program.** Atchmson, D.B.; Baars, R.E.; Fox, G.L. (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). 1979. Contract EY-76-C-03-0893-014; EY-76-C-14-2170. 34p. NTIS, PC A03/MF A01.

Analyses of US and UK fuel rods with several fuel rod mechanics codes resulted in identification of three major loading mechanisms that cause cladding failure: differential thermal expansion between solid fuel and cladding prior to initial fuel melting; pressurization of the central molten fuel region by constriction of the void volume available to contain fission gas; and processes related to extreme thermal conditions. These processes would include fuel vapor pressure loading, cladding melt-through due to coolant boiling disruption of heat transfer, and low (plenum) fission gas pressure loading of very hot cladding. Ramp rate regimes are not defined in terms of these loading mechanisms because they are not uniquely associated with any single ramp rate regime.

ENVIRONMENTAL ASPECTS

SITING

REFER ALSO TO CITATION(S) 25980

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 26308

25907 (ORNL—5529) **Recommendations concerning models and parameters best suited to breeder reactor environmental radiological assessments.** Miller, C.W.; Baes, C.F. III; Dunning, D.E. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 162p. NTIS, PC A08/MF A01.

Recommendations are presented concerning the models and parameters best suited for assessing the impact of radionuclide releases to the environment by breeder reactor facilities. These recommendations are based on the model and parameter evaluations performed during this project to date. Seven different areas are covered in separate sections.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 25865

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

25908 (HEDL-SA—2022) **Data systems in FFTF and EBR-II.** Warrick, R.P.; Ritter, W.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1980. Contract EY-76-C-14-2170. 25p. (CONF-800366—2). NTIS, PC A02/MF A01.

From Specialists' meeting on LMFBR instrumentation and control; Tokyo, Japan (31 Mar 1980).

This paper describes the Data System used to monitor operation and collect experimental data in FFTF. This data system has evolved since initial inception from a relatively simple, single computer system monitoring a relatively few (~ 1000) instrument channels important for operation to one which has increased capability to support the long-range testing needs in FFTF. The system, while still relatively simple, now contains multiple computers which normally perform independent functions. The computers, however, provide backup processing for certain simple tasks. Operator interfacing is provided through CRT's. The output capabilities of the system are described. A description of the Data System in EBR-II is also included.

25909 (HEDL-SA—2023) **Nuclear instrumentation system design in FFTF and CRBRP.** Warrick, R.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1980. Contract EY-76-C-14-2170. 30p. (CONF-800366—1). NTIS, PC A03/MF A01.

From Specialists' meeting on LMFBR instrumentation and control; Tokyo, Japan (31 Mar 1980).

The Nuclear Instrumentation System installed in the Fast Flux Test Facility (FFTF) is described. The Nuclear Instrumentation System includes equipment for monitoring neutron flux levels from shutdown to full power. Detector location and mounting provisions are described. The design basis for equipment design is provided. Detailed discussion of startup testing in FFTF follows a brief discussion of pre-delivery development work and testing. Finally, a description of the Nuclear Instrumentation System planned for the Clinch River Breeder Reactor Plant is provided.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

25910 (UNI-TR—5) **Microprocessor based flux wire evaluation and analysis system.** Peterson, D.G.; Toffer, H.; Sapp, S.P. (UNC Nuclear Industries, Inc., Richland, WA (USA)). Jan 1980. Contract AC06-76RL01857. 21p. NTIS, PC A02/MF A01.

A novel application of a microprocessor as the heart of a sophisticated data processing and analysis system at the Hanford N Reactor has been developed. Flux wires which map the neutron density distribution in the reactor are analyzed using the microprocessor system. Evaluation of flux wire activity is used to generate reactor operating limits and to monitor localized neutron flux depressions in the core.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 26273

25911 (ALO—72) **Recommended research program for improving seismic safety of light-water nuclear power plants.** (Engineering Decision Analysis Co., Inc., Palo Alto, CA (USA)). Apr 1979. Contract AC04-76DP00789. 194p. (EDAC—198-030.01). NTIS, PC A09/MF A01.

Recommendations are presented for research areas concerned with seismic safety. These recommendations are based on an analysis of the answers to a questionnaire which was sent to over 80 persons working in the area of seismic safety of nuclear power plants. In addition to the answers of the 55 questionnaires which were received, the recommendations are based on ideas expressed at a meeting of an ad hoc group of professionals formed by Sandia, review of literature, current research programs, and engineering judgement.

25912 (KFK—2820) **Observations of the behavior of gas in the wake behind a corner blockage in fast breeder subassembly geometry.** Fukuzawa, Y. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jul 1979. 44p. NTIS (US Sales Only), PC A03/MF A01.

Observations were made of gas behavior in the wake behind a 21% corner blockage in the subassembly geometry of a liquid metal fast breeder reactor. The test section used represented one half of the reactor fuel subassembly, divided along the vertical plane of symmetry through the blockage. A glass wall occupied the position of this plane. Water was allowed to flow between glass rods simulating fuel pins, the velocity being changed from 1.2 to 4.5 m/s. Argon was injected into the wake or into the flow upstream of the blockage, the injection rate being changed from 1 to 230 Ncm^3/s (standard temperature and pressure).

25913 (KFK—2827) **Dependence of diffusion theory results on the mesh size for fast reactor calculations.** Buckel, G.; Gebhardt, W.; Kiefhaber, E. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jul 1979. 49p. NTIS (US Sales Only), PC A03/MF A01.

In investigations concerning sodium void reactivities for SNEAK-9C2-assemblies inconsistencies were detected in the results coming from Δk of successive diffusion and exact perturbation calculations, respectively. Therefore, discretization and rounding errors in neutronic reactor calculations and their effects on numerical results are considered for a well known SNR-300 type benchmark problem as well as for the slightly simplified original problem.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 25805, 25979

COMPRESSED GAS

REFER ALSO TO CITATION(S) 25915

PUMPED HYDRO

REFER ALSO TO CITATION(S) 25979

THERMAL

REFER ALSO TO CITATION(S) 25806, 25807, 25808, 25809, 25810, 25811, 25812, 25813, 25814, 25871, 25940, 26040, 26041, 26042, 26043, 26048, 26072, 26073, 26078

25914 (CONF-791232—) **Thermal energy storage: fourth annual review meeting.** (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EX-77-A-29-1060. 663p. NTIS, PC A99/MF A01.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Forty-nine papers were presented at the meeting. A separate abstract was prepared for each of 48 papers. One paper appeared previously in Energy Research Abstracts. (LCL)

25915 (CONF-791232—, pp 3-10) **Thermal Energy Storage system lead center overview.** Nice, A.W. (NASA, Cleveland, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The status, goals, funding, and scheduling of Thermal Energy Storage (TES) projects are reviewed. These projects include studies of TES and Compressed Air Energy Storage for electric utilities, TES and heat recovery systems for the paper and food industries, and supporting research and technology. (LCL)

25916 (CONF-791232—, pp 25-3) **Seasonal Thermal Energy Storage Program.** Minor, J.E. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The DOE Division of Energy Storage Systems is responsible for formulating and managing research and development in energy storage technology. As one element of STOR Division's Thermal Energy Storage Program, Pacific Northwest Laboratory (PNL) was assigned management of the Seasonal Thermal Energy Storage (STES) Program in April 1979. In this overview, the STES Program incentives, objectives, and long range implementation plan for achieving program goals are described. Procurements in progress in the Demonstration Program are described in subsequent papers.

25917 (CONF-791232—, pp 35-41) **Program definition and assessment overview.** Gordon, L.H. (NASA, Cleveland, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

An essential function related to management of the overall thermal energy storage program is that of program definition and assessment. The major emphasis in this activity is the implementation of a program level assessment of thermal energy storage technology thrusts for the near and far term to assure an overall coherent energy storage program. Included are the identification and definition of potential new thermal energy storage applications, definition of technology requirements, and appropriate market sectors. This activity also includes the necessary coordination, planning and preparation associated with program reviews, workshops, multi-year plans and annual operating plans for the major lead laboratory tasks. SERI assessment tasks will be coordinated and integrated into this activity.

25918 (CONF-791232—, pp 47-55) **Thermal energy storage systems using fluidized bed heat exchangers.** Ramanathan, V.; Weast, T.E.; Ananth, K.P. (Midwest Research Inst., Kansas City, MO). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

A systems study is being conducted to determine the viability of using Fluidized Bed Heat Exchangers (FBHX) for Thermal Energy Storage (TES) in applications with potential for waste heat recovery. Of the candidate applications screened, Cement Plant Rotary Kilns and Steel Plant Electric Arc Furnaces were identified, via the chosen selection criteria, as having the best potential for successful use of FBHX/TES system. A computer model of the FBHX/TES systems has been developed and the technical feasibility of the two selected applications has been verified. Economic and trade-off evaluations are in progress for final optimization of the systems and selection of the most promising system for further concept validation.

25919 (CONF-791232—, pp 57-77) **Thermal energy storage and transport.** Hausz, W. (General Electric Co., Santa Barbara, CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The extraction of thermal energy from large LWR and coal-fired plants for long distance transport to industrial and residential/commercial users is analyzed. Transport as high temperature water is considerably cheaper than transport as steam, hot oil, or molten salt over a wide temperature range. The delivered heat is shown to be competitive with user-generated heat from oil, coal, or electrode boilers at distances well over 50 km when the pipeline operates at high capacity factor. Thermal energy storage makes meeting of even very low capacity factor heat demands economic and feasible. Storage gives the utility flexibility to meet coincident electricity and heat demands effectively.

25920 (CONF-791232—, pp 105-111) **Collection and dissemination of TES system information.** Dietrich, M.W. (NASA, Cleveland, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The objectives of this study were to determine existing applications of TES in both the US and international paper and pulp industries, to obtain and analyze the operating data from a representative number of these mills, and to transfer this information to the US paper and pulp industry. The scheduling of this work is outlined.

25921 (CONF-791232—, pp 223-231) **Thermal energy storage testing facility.** Schoenhals, R.J.; Kuehlert, H.F.; Lin, C.P. (Purdue Univ., Lafayette, IN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Development of a prototype testing facility for electrically heated thermal energy storage units is being pursued. Test procedures are being evaluated and verified by means of simultaneous redundant measurements and analysis. The quality of measurements obtained with the use of a calibrated calorimeter chamber has been improved. Testing of commercially available units is being performed, and experience gained in this activity will be used to further refine and substantiate the test procedures being formulated.

25922 (CONF-791232—, pp 262-264) **Thermal Energy Storage Test Facility.** Ternes, M.P. (Oak Ridge National Lab., TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Two loops making up the Thermal Energy Storage Test (TEST) Facility, using either air or liquid as the thermal transport fluid, are being designed and developed. These loops will be capable of cycling residential-size thermal energy storage units through conditions simulating solar or off-peak electricity applications to evaluate the unit's performance. To date, the detailed design of the liquid cycling loop has been completed and is expected to be operational in March 1980; the design of the air cycling loop has been initiated.

25923 (CONF-791232—, pp 265-270) **Mathematical modeling of moving boundary problems in thermal energy storage.** Solomon, A.D. (Union Carbide Corp., Oak Ridge, TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The goals of this project are to: develop capability for predicting the performance of TES subsystems and components using PCM's based on mathematical and physical models; develop mathematical models of the dynamic thermal behavior of TES subsystems using PCM's based on solutions of the moving boundary thermal conduction problem and on heat and mass transfer engineering correlations; and design, construct, and operate small-scale experiments to provide data for testing and improving the mathematical models. A mathematical model based on conduction in any module geometry has been completed. A physical model in slab geometry has been operated in conduction mode and natural thermal convection mode.

25924 (CONF-791232—, pp 277-281) **Life and stability testing of packaged low-cost energy storage materials.** Frysinger, G.R. (Univ. of Delaware, Wilmington). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The goals of this project are to: verify the package integrity of the chub packaged materials system for storage of coolness with application to residential air conditioning and verify life and stability of packaged material by cycling and performance testing; and determine that the moisture vapor retention characteristics of laminate film developed by DuPont is satisfactory for long-term chub performance, determine stability, mechanical integrity, and thermal performance of chubs following mechanical shock, vibration, and temperature extremes, and carry out thermal performance tests of chubs following accelerated and diurnal thermal cycling. The tests have been completed. Based on acceptable moisture retention data, a thin film laminate was selected for the chubs. A 204-lb batch of chubs was cycled 405 times on an accelerated schedule. After cycling the heat of fusion was about 70 Btu/lb based on a 30°F temperature swing.

25925 (CONF-791232—, pp 315-331) **Development of optimum process for electron beam cross-linking of high density polyethylene thermal energy storage pellets, process scale-up and production of application quantities of material.** Salyer, I.O. (Univ. of Dayton, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Research to develop a thermal energy storage system based on thermally form-stable pellets of crosslinked high-density polyethylene (HDPE) prepared by electron beam (EB) irradiation is described. The optimum EB irradiation conditions for HDPE having the highest possible heat of fusion are identified. A 250-lb batch of the optimum material was prepared and evaluated in a 12,000-Btu pilot storage unit. A 15,000-lb batch will be prepared, tested, and delivered to DOE (ORNL) for full-scale application tests in the future. To date DuPont 7040 and 8 megarads have been selected as the optimum HDPE and dose, respectively. The 250-lb batch has been prepared.

25926 (CONF-791232—, pp 333-335) **Research and advanced technology overview.** Vernon, R.W. (NASA, Cleveland, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Activities at the NASA Lewis Research Center related to heat storage research are itemized. These include studies of improved heat exchangers using phase change materials, evaluation of media for high temperature applications, and prototype thermal energy storage system hardware testing. (LCL)

25927 (CONF-791232—, pp 337-352) **Active heat exchange system development for latent heat thermal energy storage.** LeFrois, R.T. (Honeywell, Inc., Minneapolis, MN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The goals of this project are to: develop an active heat exchange system, utilizing a phase change thermal storage medium, where operating characteristics are compatible with a 250 to 350°C steam power cycle; identify and select concepts for test; design, fabricate, assemble and test laboratory scale modules; evaluate results; and recommend further development requirements; To date, heat exchanger tubes coated with 1 to 2 mil electroless nickel were tested in a 600°F molten/hydroxide environment; Latent heat extraction could not be satisfactorily demonstrated in this experiment due to low heat transfer coefficients (90 to 250 Btu/hr-ft^2-°F for salt-oil T's between 5 to 50°F).

25928 (CONF-791232—, pp 353-359) **Energy storage-boiler tank, 1979 progress report.** Chubb, T.A.; Nemecek, J.J.; Simmons, D.E. (Naval Research Lab., Washington, DC). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The objectives of this program are to: demonstrate feasibility of heat-of-fusion energy storage-boiler tank; evaluate media and heat transfer fluid properties and cycle life characteristics; perform storage media-containment materials compatibility studies; and design, build, and operate a 2 MWh storage-boiler tank. To date property determinations were completed and a eutectic salt (NaCl, KCl, $MgCl_2$) having a melting point of about 385°C, and M-terphenyl as the heat transfer fluid was selected. Compatibility studies were complete and mild steel containers were selected. The fabrication of 2 MWh storage-boiler tank is proceeding and scheduled to be completed in December, 1979. Operation and tests are scheduled through 1980.

25929 (CONF-791232—, pp 375-383) **Active heat exchange system development for latent heat thermal energy storage.** Alario, J.; Haslett, R. (Grumman Aerospace Corp., Bethpage, NY). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The overall objective of this program is the development of an active heat exchange process in a latent heat thermal energy storage (TES) system which is suitable for utility applications. Various active heat exchange concepts were identified from among three generic categories: scrapers, agitators/vibrators and slurries. The more practical ones were given a more detailed technical evaluation and an economic comparison with a passive tube-shell design for a reference application. Two concepts were selected for hardware development: (1) a direct contact heat exchanger in which molten salt droplets are injected into a cooler counterflowing stream of liquid metal carrier fluid, and (2) a rotating drum scraper in which molten salt is sprayed onto the circumference of a rotating drum, which contains the fluid heat sink in an internal annulus near the surface. A fixed scraper blade removes the solidified salt from the surface which has been nickel plated to decrease adhesion forces. An evaluation of suitable Phase Change Material (PCM) storage media with melting points in the temperature range of interest (259 to 400°C) limited the candidates to molten salts from the chloride, hydroxide and nitrate families, based on high storage capacity, good corrosion characteristics and availability in large quantities at reasonable cost. The specific salt recommended for laboratory tests was a chloride eutectic (20.5KCL 24.5NaCL 55.0$MgCL_2$% by wt), with a nominal melting point of 385°C. At this time, the hardware has been built and is being assembled and instrumented prior to test evaluation.

25930 (CONF-791232—, pp 385-390) **Heat storage in alloy transformations.** Birchenall, C.E. (Univ. of Delaware, Newark). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Heats of transformation of eutectic alloys have been measured for many binary and ternary systems by differential scanning calorimetry and thermal analysis. Only the relatively cheap and plentiful elements Mg, Al, Si, P, Ca, Cu, Zn were considered. A new method for measuring volume change during transformation has been developed using x-ray absorption in a confined sample. Thermal expansion coefficients of both solid and liquid states of aluminum and of its eutectics with copper and with silicon also were determined. Preliminary evaluation of containment materials lead to the selection of silicon carbide as the initial material for study. Possible applications of alloy PCMs for heat storage in conventional and solar central power stations, small solar receivers and industrial furnace operations will be examined.

25931 (CONF-791232—, pp 391-401) **Immiscible fluid - heat of fusion heat storage system.** Edie, D.D.; Melsheimer, S.S.; Mullins, J.C. (Clemson Univ., SC). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The primary objective of this research is to evaluate the feasibility of direct contact heat transfer in phase change energy storage using aqueous salt systems. A secondary objective is to improve knowledge and understanding of heat and mass transfer in direct contact aqueous crystallizing systems. In order to facilitate research into this energy storage device, the project was divided into four major research areas: crystal growth velocity study on selected salts; selection of salt solutions; selection of immiscible fluids; and studies of heat transfer and system geometry. All four studies have been completed. Marcol 72 and Therminol 60 were the immiscible fluids selected for further testing. The overall system operation remains to be bench-scale tested.

25932 (CONF-791232—, pp 403-411) **Aquifer thermal energy storage program.** Fox, K. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The purpose of this program is to stimulate the interest of industry by demonstrating the feasibility of utilizing an aquifer for seasonal thermal energy storage. Technical, economic, environmental and institutional feasibility are being considered. The scheduling of the program is discussed.

25933 (CONF-791232—, pp 413-561) **Compendia of seasonal thermal energy storage aquifer thermal energy technical information.** Hostetler, D.D. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The primary goal of the Compendia Subtask is to organize, summarize, and communicate information related to Seasonal Thermal Energy Storage (STES). Current activities include: a cross-referenced STES library with over 750 publications, and developing an annotated bibliography of library contents.

25934 (CONF-791232—, pp 563-568) **Technical support program.** Myers, D.A. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The goals of this project are to: obtain data which can be derived only from a field test facility; perform drilling and testing studies at two sites in the State of Washington in order to characterize the aquifer; develop a conceptual design for the surface heat exchange facility; develop a preliminary test plan; develop mathematical models of the hydrology of the proposed sites; and search for additional sites applicable for STES/LETF activities. Work has started on geohydrologic characterization at two possible field research pilot plant sites (Leading Edge Test Facilities).

25935 (CONF-791232—, pp 569-573) **Technical support program.** Eliason, J.R. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The Technical Support Program is designed to provide support to the Seasonal Thermal Energy Storage Program which has the overall objective of commercially demonstrating the applicability of seasonal thermal energy storage. The initial activities of this task are a parallel effort primarily directed toward support of the Aquifer Thermal Energy Storage Demonstration Program. These activities will include social, economic, environmental assessment, and technical research and development studies to provide a sound technical base for the Demonstration Projects. The long-range task goals include investigation and evaluation of other seasonal thermal energy storage concepts which may be considered for future emphasis. Studies will be conducted independent of the ATES Program, but will be designed and timed to provide key input to the program. Aquifer Technology Projects funded during FY-1979 by ORNL have been reviewed. The on-going studies are listed. (LCL)

25936 (CONF-791232—, pp 575-579) **Preliminary conclusions of a technical feasibility study of low temperature therm.l energy storage in the TVA region.** Betbeze, A.R. (Tennessee Valley Authority, Chattanooga). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The technology required to implement Low Temperature Thermal Energy Storage (LTTES) is fully developed and commercially available, and no foreseeable technical barriers to implementation in the TVA region are apparent. The major constraint on system feasibility is attributed to possible environmental effects and economic practicality and not to technical limitations. The major development work now required is the determination of the long-term effects on the aquifer and adjacent groundwaters from the implementation of an LTTES plant.

25937 (CONF-791232—, pp 581-589) **Seasonal thermal energy storage in aquifers: mathematical modeling studies in 1979.** Tsang, C.F. (Lawrence Berkeley Lab., CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

This research was undertaken to: develop methods for evaluating hydrodynamic and thermal factors for aquifer thermal energy storage (ATES); Disseminate information on aquifer thermal energy storage; provide technical support for the Seasonal Thermal Energy Storage (STES) Program; develop numerical models to simulate water and heat flow in geologic media; use these models to predict and evaluate performance of aquifer thermal energy storage tests; and compile, publish, and distribute a bimonthly ATES Newsletter. A numerical model was developed, verified, and tested to simulate and predict ATES performance. Modeling of the Auburn field test was completed with evaluation of the first and second heat injection/recovery cycles.

25938 (CONF-791232—, pp 591-599) **Cold water aquifer storage.** Reddell, D.L.; Davison, R.R.; Harris, W.B. (Texas A and M Univ., College Station). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

A cold water aquifer storage experiment was conducted at Texas A and M University during the winter of 1979. Parameters for designing cooling ponds to chill water from 295 to 277°K were developed. In addition, data on the movement of chilled water through a highly permeable, shallow, unconfined aquifer were obtained. This study provided a least-cost method for obtaining data on chilled water movement in aquifers to verify numerical models and to evaluate problems with chilled water storage. Regional flow in the aquifer and natural recharge to the aquifer during the second wettest year in history reduced the thermal energy recovery from an expected 40 to 20%. No aquifer plugging problems were experienced during injection and recovery operations. The cooling pond operation was an exceptional success.

25939 (CONF-791232—, pp 607-619) **Equilibrium geochemical modeling of a seasonal thermal energy storage aquifer field test.** Stottlemyre, J.A. (Pacific Northwest Lab., Richland, WA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

A geochemical mathematical modeling study designed to investigate the well plugging problems encountered at the Auburn University experimental field tests is summarized. The results, primarily of qualitative interest, include: (1) loss of injectivity was probably due to a combination of native particulate plugging and clay swelling and dispersion, (2) fluid-fluid incompatibilities, hydrothermal reactions, and oxidation reactions were of insignificant magnitude or too slow to have contributed markedly to the plugging, and (3) the potential for and contributions from temperature-induced dissolved gas solubility reductions, capillary boundary layer viscosity increases, and microstructural deformation cannot be deconvolved from the available data.

CHEMICAL

25940 Materials and performance characteristics of the HYCSOS chemical heat pump and energy conversion system. Gruen, D.M.; Mendelsohn, M.; Sheft, I.; Lamich, G. (Argonne National Lab., IL). pp 1931-1946 of Hydrogen energy system. Veziroglu, T.N.; Seifritz, W. (eds.). New York, NY; Pergamon Press (1978).

An efficient and cost competitive chemical heat pump and energy conversion system driven by solar, other low grade heat sources or by fossil fuels (gas or oil) has been under development at the Argonne National Laboratory since 1975. The HYCSOS concept involves the use of two different metal hydrides with different free energies of formation enabling hydrogen to flow from one to another of the hydrides under the influence of appropriate thermal gradients. In the chemical heat pump mode, hydrogen flows between two pairs of four vessels which take the place of the generator/condenser and evaporator/absorber elements of conventional absorption refrigerators. The functions of generator/absorber and condenser/evaporator are interchanged at the end of each two minute cycle. The chemical heat pump materials are based on the AB_5 alloys which combine a remarkable ability to absorb hydrogen rapidly and reversibly at moderate pressures near ambient temperatures with a large hydrogen storage capacity. The recent development of LaNi/sub 5-x/Al/sub x/ ternary alloys has provided a versatile class of materials whose hydrogen dissociation pressures can be varied in a precisely predetermined manner by almost three orders of magnitude. With these new materials it will be possible to operate the chemical heat pumps over a wide range of preselected temperatures and pressures. The current status and prospects for the future development of the HYCSOS system are discussed.

BATTERIES

REFER ALSO TO CITATION(S) 26129, 26737

DESIGN AND DEVELOPMENT

25941 (AD-A—077685/6) **Calcium inorganic electrolyte battery development. Interim technical report, August 1977-January 1979.** Higgins, R.L.; Elliott, L. (Eagle-Picher Industries, Inc., Joplin, MO (USA). Electronics Div.). Jun 1979. Contract F33615-77-C-2020. 81p. NTIS, PC A05/MF A01.

The objectives of this program are based on the desire to develop a calcium/oxyhalide system comparable to the lithium/oxyhalide system with respect to energy density and rate capabilities, while overcoming the problems of voltage delay and safety hazards. This project is directed toward assessing basic performance, safety, storage, and voltage delay of the calcium/oxyhalide system for use in Air Force applications. Early small cell development is designed for use in life support, rescue equipment, and spacecraft power, while Phase II development of large cells up to 10,000 Ampere hours is anticipated for use in missile standby and emergency ground power systems. Specific factors of concern in these applications are low volume, performance over a temperature range -40 F to 165 F, safety, and long shelf life.

25942 (EPRI-EM—1323) **Development of the sodium-antimony trichloride battery for utility application. Final report.** (ESB Technology Co., Yardley, PA (USA)). Feb 1980. 167p. NTIS, PC A08/MF A01.

An overview is presented of the development of a moderate-temperature molten salt Na/β-alumina/$SbCl_3$ battery for load leveling and peaking applications. Cell tests are described on 2-Wh disc cells and 20-, 50-, and 80-Wh tube cells. Their charge-discharge characteristics are used to project the design and performance of 200-Wh single tube subcells and 625-kWh modules for a 20-MW, 100-MWh load leveling battery. An updated price analysis predicts a price of $74/kWh for truck-transportable 625-kWh modules, including weatherproof insulating housing, cooling system, voltage and temperature monitoring accessories. Basic electrochemical investigations are presented as the basis of an understanding of the corrosion of molybdenum and nickel current collectors in the positive mix. Tungsten-coated nickel collectors are the preferred long-life design. Polymeric sodium seals did not survive in larger cells. Compressed aluminum gasket seals are recommended for the sodium compartment and Teflon gasket seals, for the positive compartment. Cycle life of 20-Wh zeta-beta tube cells reached 700 deep cycles on a 5-h D/7-h C routine at 220 +- 10°C. Fifty watt-h cells using Ceramatec Inc. zeta-beta have passed the 800 cycle mark without beta penetration except at glass-to-beta seals. Sulfur additives in the $SbCl_3$-$NaAlCl_4$-carbon black positive mix increased energy output markedly; however, the best Na/β/$SbCl_3$ cell designed for long life at 220°C will yield only 50 to 60% of the energy per unit volume of Na/β/S cells operating at 325°C. Overall system economics and performance favor the Na/β/S system. Sulfur added to the positive mix attacks the nickel current collector in spite of tungsten protective coatings. Fine 0.3 mm dia wire in the spiral current collector was totally dissolved in cells with significant sulfur additive in the positive mix during a cycle life of 300 to 500 deep cycles. 51 figures, 46 tables.

25943 (EPRI-EM—1341) **Development of advanced batteries for utility application. Interim report.** Mitoff, S.P. (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Feb 1980. 345p. NTIS, PC A15/MF A01.

The interim results of a program to develop sodium-sulfur batteries for utility load-leveling applications are presented. The reporting period is October 1977 through May 1979. During this period a major scale-up to the first full-size (615 mm x 49.3 mm od, 168 Ah) cells was acomplished. Safety tests demonstrated the need for a safety insert for the sodium to limit the rate sodium and sulfur could react in the event of a beta tube failure. Performance testing demonstrated a cell capacity greater than the 168 Ah design value, but the electrical resistance was approximately 30% greater than the design value. Two concepts for a 100-kWh battery module were investigated. The first uses forced-convection nitrogen cooling. The second uses liquid organic coolant; it is more compact and less costly, and provides better temperature control. However, the organic coolant design introduces potential fire hazards and corrosion concerns. The use of beta" electrolyte in test cells was deferred in favor of beta electrolyte because the resistance of the beta" was found to increase rapidly with time and the ceramic had a short lifetime. Thus, the advantages of the low initial resistivity of beta" compared to beta were lost after a few cycles of operation. The duplex chromized cell containers continued to show excellent corrosion resistance during cell tests of up to 17 months' duration. A model was developed and experiments were performed to characterize the performance of the resistive mat between the polysulfides and the ceramic electrolyte. Also, a new measurement of the entropy

change associated with the sodium-sulfur reaction was completed. These measured values are lower than previously published values. In exterior seal development, the thermocompression bond seals were successfully used with full-sized cells, and tests showed seal strength of ~ 27.6 x 10^6 pascals (~ 4000 psi).

PERFORMANCE AND TESTING

25944 (DOE/NASA/1044—6) **Pulse charging of lead-acid traction cells.** Smithrick, J.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). May 1980. Contract EC-77-A-31-1044. 23p. (NASA-TM—81513). NTIS, PC A02/MF A01.

Pulse charging was investigated as a method of rapidly and efficiently charging 300-Ah lead-acid traction cells for an electric vehicle application. A wide range of charge pulse current square waveforms were investigated, and the results were compared to constant current charging at the time-averaged pulse current values. In addition, experiments were undertaken to define the effect of peak charge pulse current, peak discharge pulse current, duty cycle, and pulse frequency for a Romanov-type waveform. For each of the above methods the charge was terminated when either 10% of the charge pulse current produced gas or the cell temperature reached 120°F. In order to explore ways to improve the energy and ampere-hour (amp-hour) efficiency of pulse charging in a limited study, two alternate methods of charging were compared. In method 1 the cell was pulsed throughout the entire charge. In method 2 the cell was initially charged at a constant current, and after the onset of gassing was switched to pulse charging. Experimental results indicate that, on the basis of amp-hour efficiency, pulse charging offered no significant advantage as a method of rapidly charging 300-Ah lead-acid traction cells when compared to constant-current charging at the time-average pulse current value. There were, however, some disadvantages of pulse charging, in particular, a decrease in charge amp-hour and energy efficiencies and an increase in cell electrolyte temperature. The constant-current charge method resulted in the best energy efficiency with no significant sacrifice of charge time or amp-hour output. 4 figures, 4 tables.

25945 (SAND—79-1383) **Long-term lithium battery tests. II.** Levy, S.C. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 16p. NTIS, PC A02/MF A01.

Data from the second 6-month period of a 6-year test of ambient-temperature lithium batteries are reported. Lithium-sulfur dioxide cells from three manufacturers and lithium-polycarbon monofluoride cells from a fourth are included. One year's storage at room temperature or below had a minor effect on capacity. Storage at 49°C resulted in a significant capacity loss. Two mechanisms were identified that may result in premature failure of cells stored at elevated temperatures: corrosion of an aluminium-to-tantalum weld in the positive terminal, and an attack on the glass-to-metal seal in the header. Continuous discharge under a pulsed load resulted in a considerable loss of capacity. A white deposit containing oxide, sulfate, and some carbonate was found in these cells at the anode-to-case contact. 3 figures, 2 tables.

25946 **On the economic assessment and optimization of energy storage systems.** Davitian, H.; Leigh, R.W. (Brookhaven Natl Lab, Upton, NY). *Energy (Oxford);* **4**: No. 6, 1099-1105(Dec 1979).

A method is described for the economic optimization and comparative evaluation of various energy storage systems in a given application. The method is particularly useful in examining the economics of devices with short lifetimes, and can be employed whenever a device lifetime can be expressed as a function of physical parameters which are related to the manner in which the device is used. Given a detailed description of the pattern of use of the device in the application, the device lifetime can be calculated. The economic consequences of changes in lifetime result from the dependence of the capital recovery factor on device lifetime. It is shown how analyses can be made of changes in technical performance characteristics or changes in the pattern of use of the storage device to determine their effects upon the annual cost of energy storage and to determine minimum cost systems. The method is applied to determine the economically optimal size for a system of batteries in a specified application with explicit consideration of the trade-off between battery capacity and battery life.

25947 **Long life silver-zinc cells: application to the BB519/U battery.** Karpinski, P.; Serenyi, R. (Yardney Electric Corp., Pawcatuck, CT). pp 169-173 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The BB519/U 24-V, 25-Ah, rechargeable Ag/Zn battery is described in detail. Novel features are the presence of potassium titanate fibers in the negative electrode and the introduction of titanium into the cellulosic separators. Results of environmental and (especially) electrical tests are given. Physical and electrical characteristics are tabulated. A comparison of this battery with other Ag/Zn batteries and batteries containing other active materials is made. 4 figures, 3 tables. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 26033

25948 (ANL/OEPM—78-4) **Monitoring stibine and arsine in lead-acid battery charge gas and in ambient air: development and testing of a field kit.** Varma, R.; Cook, G.M.; Yao, N.P. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 31p. NTIS, PC A03/MF A01.

An industrial lead-acid battery (5 kWh) has been found to generate a significant amount of stibine and arsine during the overcharge period of a charge cycle and during equalization charging. Therefore, a stibine/arsine detection kit was developed for use in field collection and evaluation of toxic gas release. The equipment includes a metering pump to provide a constant gas flow rate, an absorption tube to collect the SbH_3 and AsH_3, and the necessary controls, filters, etc. A portable spectrophotometer is used to analyze for antimony. The absorbed solution is analyzed for arsenic at the laboratory. This kit was used to collect and measure the stibine and arsine generated from an industrial lead-acid battery and the ambient air around lead-acid modules during cycling. 8 figures, 6 tables.

25949 **Alkali cell.** Takamura, T.; Kanada, Y.; Suzuki, S. (to Toshiba Corp., Kawasaki, Kanagawa (Japan); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,433,487/B/. 14 Dec 1978. 4p. (In German).

The invention deals with materials for negative zinc electrodes of alkali cells, whose positive electrodes consist of electrochemically effective materials such as silver oxide, manganese dioxide or iron hydroxide. The material of the negative zinc electrode contains fine zinc particles, a small percentage by weight of zinc oxide, an inorganic oxide of a metal that is not as precious as zinc, and a small percentage of anorganically produced material. A content of 0.1 to 10 percent by weight of powdery cellulose in the salts and/or boron oxide is specified.

25950 **Structure and performance of sintered iron electrodes.** Bryant, W.A. (Westinghouse Electr Corp, Pittsburgh, Pa). *Electrochim. Acta;* **24**: No. 10, 1057-1060(Oct 1979).

The discharge capacity of an electrode prepared by the sintering of sponge iron powder is found to be highly dependent upon the density of the electrode. Maximum capacities (near 0.4 Ah g^{-1}) are determined for electrodes having densities within the range from 21.5 to 23.5% of the theoretical density of iron. High capacity is also found to be favored by low charge current density (25 mA cm^{-2}). The capacity of a low density electrode (19.6% of the theoretical density of iron) is found to be much less affected by discharge current density than are higher density electrodes. Charge and discharge potentials are also determined as a function of electrode density. Large (400 cm^2) electrodes of the optimum density are prepared and found to have the same large capacity as their smaller, test-size counterparts. This work is pertinent to electric vehicle propulsion.

ENERGY MANAGEMENT AND POLICY

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 25955, 25956, 25962, 25963, 25964, 25965, 25966, 25967, 25968, 25969, 25970, 25971, 25976, 25983, 25985, 26002, 26003, 26055

25951 (EPRI-EA—1357(Vol.1)) **Supply models with feedback features. Volume 1. Executive summary. Final report.** Day, R.H. (Economic Dynamics, Inc., Malibu, CA (USA)). Mar 1980. 41p. NTIS, PC A03/MF A01.

Economic Dynamics, Inc. has endeavored to develop an adaptive economics methodology for explaining and projecting energy supply. The ultimate goal is the specification of improved, realistic, operational, dynamic, energy-supply models. In pursuit of this goal, four specific studies were completed. First, the theoretical ingredients of adaptive economics were integrated into a coherent methodological framework within which specific modeling studies could be undertaken. Second, the recursive programming approach to adaptive modeling was reviewed, applied studies of petroleum and coal mining sectors were reviewed, and a new experimental multisector, temporary-equilibrium, recursive programming model was developed and tested. Third, a careful review of the coal-mining sector, and of past coal-supply analyses was undertaken with a view to establishing the feasibility of developing improved adaptive models of the coal-mining sector. Fourth, the system-dynamic meth-

odology was carefully reviewed, evaluated and illustrated with an experimental model of nuclear power supply. The work established the feasibility of using concepts of adaptive economics for developing energy-supply models that would provide plausible explanations of how energy-supply problems emerge and how various policies formulated within the private sector will influence energy supply in the future. The recursive programming involving optimization subject to behavioral constraints and environmental feedbacks would appear to offer a flexible and well-tested approach for carrying out adaptive modeling studies. The controversial system dynamics methodology offers a useful approach when care is taken to represent decision making by coherent, empirically meaningful rather than ad hoc behavioral rules.

25952 (EPRI-EA—1357(Vol.2)) **Supply models with feedback features. Volume 2. A review of adaptive economics modeling. Final report.** Day, R.H. (Economic Dynamics, Inc., Malibu, CA (USA)). Mar 1980. 225p. NTIS, PC A10/MF A01.

Economic Dynamics, Inc. has endeavored to develop an adaptive economics methodology for explaining and projecting energy supply. The ultimate goal of this research is the specification of improved, realistic, operational, dynamic, energy-supply models. As a contribution to this overall objective, this volume presents the theoretical framework of adaptive economics and the structure and applications of recursive programming, a methodology which has proven to be useful for adaptive economic modeling. Part I deals with adaptive economics: a general framework, methodologies, adaptive goal-adjustment models, and the theoretical link between behavioral rules and macroeconomic dynamics. Part II is devoted to recursive programming: general concepts, characteristic features, a recursive programming model of the petroleum industry, and a multisector study of resource allocation and alternative energy supplies.

25953 (EPRI-EA—1357(Vol.3)) **Supply models with feedback features. Volume 3. Modeling production, investment, and technological change in the coal sector: a methodological review and evaluation. Final report.** Day, R.H. (Economic Dynamics, Inc., Malibu, CA (USA)). Mar 1980. 109p. NTIS, PC A06/MF A01.

Economic Dynamics, Inc. has endeavored an adaptive economics methodology for explaining and projecting energy supply. The ultimate goal of this research is the specification of improved, realistic, operational, dynamic, energy-supply models. This volume is concerned with the prospects for applying adaptive economic methodology for studying the supply of coal and its response to changing external circumstances and government policies. Specifically, the report presents (1) a review of the salient characteristics of the US Coal Mining industry, (2) a summary of several economic analyses concerning the industry, (3) a review of a prototype recursive programming model of the coal sector, and (4) a discussion of the feasibility of building an improved operational, adaptive model of the industry. In regard to the last topic, it is found that the methodology and empirical ingredients do exist for greatly improving dynamic models of coal supply.

25954 (EPRI-EA—1357(Vol.4)) **Supply models with feedback features. Volume 4. System dynamics in energy modeling. Final report.** Day, R.H. (Economic Dynamics, Inc., Malibu, CA (USA)). Mar 1980. 225p. NTIS, PC A06/MF A01.

Economic Dynamics, Inc. has endeavored to develop an adaptive economics methodology for explaining and projecting energy supply. The ultimate goal is the specification of improved, realistic, operational, dynamic, energy-supply models. As a contribution to this overall objective, this volume reviews the system-dynamics methodology, illustrates it with a heuristic model of uranium, and surveys the statistical/econometric methodology for improving the empirical content of such models. An evaluation concludes the report. Briefly, it was found that the system-dynamics methodology provides a readily learned and easily understood expository tool for illuminating dynamic interrelationships such as are involved in adaptive models of energy supply. It has several important limitations, however. These are primarily, inadequate means for incorporating technological detail at sufficiently micro levels and lack of representation of explicit economizing behavior (optimizing). The methodology has usually been applied to conceptual models for which careful empirical estimation has not been performed. This report indicates that new progress in statistical/econometric methodology should help rectify this shortcoming. It should be memphasized, however, that carefully designed simulations of conceptual (as opposed to empirical models) can and should play a major role in the analysis of complex dynamic systems even when good empirical data are lacking. System dynamics provides one useful approach for such exercises.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 25299, 25962, 25963, 25964, 25965, 25968, 25969, 25981, 26055, 26057

25955 (ANL/AA—14(Vol.1)) **Framework for projecting employment and population changes accompanying energy development.** Stenehjem, E.J.; Metzger, J.E. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 181p. NTIS, PC A09/MF A01.

This report provides a framework which energy planners can use to readily estimate the size and timing of the population and employment changes associated with energy development. The direct employment requirements for eight different technologies are listed. This direct employment requirement can be combined with the set of employment multipliers and other information provided to obtain practical estimates of the employment and population impacts of new energy development. Some explanation is given for the variation of the multipliers among counties in the same region. A description is presented of a demographic model for deriving the annual population changes that can be expected as a result of in-migrating workers and their families. Several hypothetical examples of the procedure for making the calculations are discussed as practical exercises in using the multipliers. The necessary data are provided for obtaining estimates of population and employment changes in any county in the US.

25956 (ANL/AA—14(Vol.2)) **Framework for projecting employment and population changes accompanying energy development.** Stenehjem, E.J.; Metzger, J.E. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 85p. NTIS, PC A05/MF A01.

In this report, gravity models and linear-programming techniques for estimating the spatial distribution of new residents are described. The advantages and disadvantages of each are discussed, and several models are recommended and given appropriate demonstration to enhance user understanding. A categorization of public service and facility requirements follows, according to urban and rural type and size of communities. These requirements are explained and listed in tabular form, with examples of how the user can derive the requirements for an energy-impacted community of a particular size and type. An appendix contains technical information describing the spatial-assignment models.

25957 (EPRI-EA—1356) **Econometric analysis of the behavior of natural resource prices. Final report.** Smith, V.K. (Resources for the Future, Inc., Washington, DC (USA)). Mar 1980. 187p. NTIS, PC A09/MF A01.

The findings of an econometric analysis of the relationship between the rates of change in mineral's prices and the rate of interest are reported. The rationale for this specification results from micro models of the behavior of a firm extracting an ore from a finite stock. This empirical analysis considers the movements in 12 minerals, including both metals and fuels, and three aggregate price indexes over the period 1900 to 1973. Five interest-rate series, distinguished according to the risk and degree of liquidity of their assets, were each considered for each of the price series. The econometric analysis involved extensive searching of alternative specifications of the relationship between the rates of change in the natural resource's price and functions of each interest rate. Econometric models within five general classes were considered to allow for the effects of expectations through the variety of lag structures considered and for comparability in risk and liquidity of holding a mineral. These final models were estimated over a part of the sample period and evaluated by their forecasting performance outside the sample period. In order to gauge the contribution of economic theory underlying these models, they were each compared with the forecasting performance of naive time-series models.

25958 (ORAU/IEA—80-8(M)) **Cost comparison of energy projects: discounted cash flow and revenue requirement methods.** Phung, D.L. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). May 1980. Contract AC05-76OR00033. 49p. NTIS, PC A03/MF A01.

Both the discounted-cash-flow (DCF) and the revenue-requirement (RR) methods are frequently used in the cost analysis of energy projects. Each is uniquely needed in special circumstances, but in the early stages of most ventures, the RR method appears to be more useful. This paper provides simple formulations for the two methods and some special cases of interest to costing practices. Both formulations are applicable to either free or regulated enterprises and in constant or inflated dollars. It is stressed that the interpretation of cost results depends on the selection of cash-flow streams and/or the intent of revenue requirements. Several numerical examples are given.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 25983

25959 (CONF-800309—6) **Costs of climate impacts.** Roberts, W.O. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA)). Mar 1980. Contract AC02-79EV10281. 9p. NTIS, PC A02/MF A01.

From International workshop on the energy/climate interactions; Munster, F.R. Germany (3 Mar 1980).

The surest prospect for future world climate patterns is that they will differ from present ones. What is uncertain is how much, and exactly in what way in different geographical regions. The anthropogenic CO_2 increase will probably exceed the unknown forcing functions of natural climate change within 30 to 60 years. It is not unlikely that by AD 2040 the world's climate, driven by the CO_2 increase, will enter a domain warmer than any within the past few million years. The costs of averting this climate change or of absorbing its impact are likely to be huge, even though today imponderable. Not least among these are intangible and unquantifiable costs associated with changes in human values and the quality of everyday life for future generations.

25960 (DOE/EV/10274—1) **Potential of mediation for resolving environmental disputes related to energy facilities.** (American Management Systems, Inc., Arlington, VA). Dec 1979. Contract AC02-79EV10274. 106p. NTIS, PC A06/MF A01.

This study assesses the potential of mediation as a tool for resolving disputes related to the environmental regulation of new energy facilities and identifies possible roles the Federal government might play in promoting the use of mediation. These disputes result when parties challenge an energy project on the basis of its potential environmental impacts. The paper reviews the basic theory of mediation, evaluates specific applications of mediation to recent environmental disputes, discusses the views of environmental public-interest groups towards mediation, and identifies types of energy facility-related disputes where mediation could have a significant impact. Finally, potential avenues for the Federal government to encourage use of this tool are identified.

25961 (DOE/EV/10274—2) **Appication of interstate compacts to energy-facility siting.** (American Management Systems, Inc., Arlington, VA). Oct 1979. Contract AC02-79EV10274. 69p. NTIS, PC A04/MF A01.

This paper examines the nature and function of interstate compacts in the US, and explores their potential for helping to resolve environmental issues related to the siting and permitting of energy-producing facilities (e.g., power plants, synthetic fuel plants). Elements of state energy facility-siting programs are identified, and the ability of interstate compacts to assist in accomplishing each element is analyzed. This analysis provides the basis for assessing the potential capabilities and limitations of compacts, and for initially estimating the possible benefits of a Federal program to promote the formation of compacts to address regional energy-siting issues.

25962 (EPRI-WS—78-95) **Workshop proceedings: integration of environmental considerations into energy-economic system models.** Gruhl, J. (ed.). (Sigma Research, Inc., Richland, WA (USA)). Oct 1979. 284p. (CONF-7910132—). Dep. NTIS, PC A13/MF A01.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

A separate abstract was prepared for each of 10 invited papers, which attempt to place some perspective on the complex relationships of economic, environmental, and social impacts. Section 1 contains an introduction and executive summary. Section 2 contains broad concerns expressed and Section 3 recommends research objectives identified at the workshop. Supplementary materials are presented in an appendix following the presentation of the invited papers in Section 4.

25963 (EPRI-WS—78-95, pp 4.3-4.15) **Measuring the structural economic consequences of interrelated energy and environmental policy decisions.** Thompson, R.G. (Univ. of Houston, TX). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

Approaches to integrate environmental considerations into large-scale energy-economic models are discussed. This modeling capability is necessary to assess national and regional impacts of changes in supplies and demands for energy, water, capital, and materials that are being induced by uniform technology standards for pollution control. Extensive structures and technical resources already exist for integrating, at least initially, important environmental considerations in large-scale energy-economic systems models. Specific areas of future research are indicated. (MCW)

25964 (EPRI-WS—78-95, pp 4.17-4.35) **Modeling: environment and energy for policy analysis.** House, P.W. (Dept. of Energy, Washington, DC). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

A history of the Strategic Environmental Assessment System (SEAS) is presented. Its components and applications are described. The subroutines examined are ABATE (the abatement cost feedback modules); SOLID WASTE (the solid waste recycling module); STOCKS (the material reserves module); ESNS (the energy use module); RESGEN (the residual generation module); TRANSPORT; LAND USE; REGION (the assignment of processes and associated activities to subnational regions moduel); QUALITY (the environmental quality indicators module). A case study of the use of SEAS in DOE is followed in the analysis of the 1977 National Energy Plan.

25965 (EPRI-WS—78-95, pp 4.37-4.50) **Wisconsin/IIASA energy/environment models: an overview and recent applications.** Foell, W.K. (Univ. of Wisconsin, Madison). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

Studies conducted by the University of Wisconsin in collaboration with the International Institute for Applied Systems Analysis has focused on regional analyses. Regions studied include Wisconsin, Austria, the German Democratic Republic, and the Rhone-Alpes region in France. Five procedures characterizing the approach to the analyses are: define objective (goals, policies, rules); define and bound system (space, time, kind); descriptive analysis (data, models); prescriptive analysis (objectives, constraints, analysis of uncertainty); and embedding (communication, preferences, subjectivity). An output of the work has been the development of an evolving family of approaches and models whose applicability has been examined for a variety of conditions under different constraints of data availability. The family of models has 4 major components: socio-economic activity models; end-use energy demand models; energy conversion and supply models; and environmental impact models. Some applications of the models are indicated.

25966 (EPRI-WS—78-95, pp 4.77-4.86) **Hierarchical decomposition approach to environmental policy analysis.** Marcuse, W. (Brookhaven Nationl Laboratory, Upton, NY). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

A methodology is presented for environmental analysis that starts with the regional and national models - in this case the Multi-Regional Energy System Optimization Model (M-RESOM) and the Brookhaven Energy System Optimization Model (BESOM) - used in a mode for technology assessment. The linkage from BESOM through the National Long-Term Interindustry and Transactions Model (LITM), also known as the Hudson-Jorgenson Model, ensures that the effects of energy prices and capital requirements on the economy are properly accounted for. Disaggregation to sectors is made through the Brookhaven National Laboratory-University of Illinois input-output model; and the national energy supply, energy demand, and nonenergy sectoral outputs are calibrated (used as control totals) for the regional model. The regional model is then used for energy siting through the County Level Electric Facility Siting Model (CLEFS) and as a check on the geographic disaggregation for energy activty through the Office of the Bureau of Economic Research Service (OBERS) projections. By following either path, residuals can be generated by the National Emissions Data System (NEDS) or by allocating the regional emissions in accordance with the outcome of the siting model. Finally, the emissions now localized at the county level are fed into the emissions transport model that determines the air quality.These can be used with a damage function to determine the health impact of energy generation emissions and, with appropriate coefficients, to determine the health impacts of extraction, transport, and processing. The structure needs extensions to incorporate nonhealth-related environmental consequences.

25967 (EPRI-WS—78-95, pp 4.87-4.102) **Regional Environmental System (RES) experiences.** Mar, B.W. Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

RES projects have attempted to broaden the perspective of regional analysis by exploring the integration of engineering, ecological, and economic concepts. Furthermore, advances in system analysis and software development within each of these separate fields were realized. Efforts to introduce new knowledge and methodology into the policy and decision-making arenas revealed that knowledge from other fields needs to be considered and that the gap between what is known and what is practiced is very large. While the research community can resolve research problems, it cannot

resolve utilization problems without institutional changes. The RANN/RES effort was not a large-enough perturbation to gain widespread utilization of RES findings; rather, the effort represented a series of demonstrations that indicated what could be accomplished in selective instances.

25968 (EPRI-WS—78-95, pp 4.103-4.124) **Integrating environmental dimensions into economic-demographic impact projection models.** Leistritz, F.L.; Murdock, S.H.; Jones, L.L. Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

There is a need for models capable of developing integrated projections of economic, demographic, and environmental effects of large-scale energy projects. A number of computerized economic-demographic projection models have been developed, and such models may provide a useful framework for building more-comprehensive modeling systems that incorporate environmental impacts. The structure and capabilities of one such economic-demographic projection model are described in this paper. It would appear that this model would provide a particularly robust framework for estimating environmental effects by type, timing, and location because it contains input-output coefficients specific to the study area, provides projections of population at the county and subcounty level, and contains an extensive data file of project parameters for each project of interest. Integration of environmental dimensions into the economic-demographic model would be accomplished in three major steps. Primary impacts of a new energy facility would be estimated from project-specific engineering information. Secondary impacts related to expansion in local trade, service, and industrial sectors would be estimated by first estimating coefficients describing the additional resource use or residuals production resulting from a one unt (e.g., $1 million) increase in the output (or value added) of each sector.Residuals production and resource use/conversion from primary and secondary sources could be readily aggregated for reporting. In addition, these estimates could be used as inputs to a variety of natural system models in order to trace higher-level environmental effects. The model described was developed by researchers from North Dakota and provided baseline and single- or multiple-project impact projections for all 8 state planning in North Dakota.

25969 (EPRI-WS—78-95, pp 4.125-4.157) **Predictive qualities of environmental information in energy models.** Gruhl, J. (Massachusetts Inst. of Tech., Cambridge). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

Range of validity is a key issue in the development and use of complex predictive models. This is particularly so for the rapidly growing number of energy/environmental models presently being used for policy analysis without explicit specifications of uncertainties associated with the results. This paper briefly outlines basic limitations in the usefulness of environmental information that is integrated into energy-economic system models. Initially some lists are presented of the types of environmental information that have been, or could be introduced into large energy models. It is quickly apparent that the principal constraint on the predictive qualities of such information is the level of geographic disaggregation in these large models. Other types of structurally introduced inaccuracies are discussed, as well as a number of systematic methodologies for correcting or compensating for these inaccuracies through probabilistic descriptions of ranges or through structural improvements. In addition to structural inexactness, there is also a lack of predictive quality due to uncertainties in environmental data. An example of the magnitude of this effect is presented, along with a suggested method for identifying the relative importance of those incertainties as a means of creating priorities for future research and development. In the example and discussions the primary focus is on routine atmospheric emissions from coal-fired electric generating facilities and their suspected impact upon public health. Some recommendations for future work are presented as suggested additions to research plans.

25970 (EPRI-WS—78-95, pp 4.159-4.174) **Modeling the value structure for environmental impacts.** Keeney, R.L. (Woodward-Clyde Consultants, San Francisco, CA). Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

Environmental problems usually involve multiple, conflicting objectives, large uncertainties concerning possible environmental impacts, and individuals or groups whose preferences are very different yet very important in choosing an alternative. If one wishes to influence the decision-making process using analysis, these issues should be addressed. One critical aspect, usually conducted informally, involves weighing the advangages and disadvantages of the possible impacts of various alternatives by each of the interested parties. A multi-attribute utility model, called a utility function, quantifies the preferences of an interested party in a manner convenient for integration with an impact model, so that formal evaluation of the alternatives is logical and straightforward. Using the utility functions of various interested individuals and groups, it is possible to examine preference structures and their implications to illumiate conflicts, focus discussion, generate creative alternatives, and promote constructive compromises. In this paper, the basic ideas of multi-attribute utility are presented and placed in the context of a decision-making framework. The manner in which this aids the analysis of environmental issues is discussed. Several problems are surveyed in which multi-attribute utility was used on environmental components. These include siting nuclear power facilities, developing fisheries, controlling a forest pest, examining energy policy, and transporting hazardous materials.

25971 (EPRI-WS—78-95, pp 4.175-4.188) **Incorporation of environmental considerations into the regional energy location model.** Eberhart, R.C.; Eagles, T.W..; Cohon, J.; Revelle, C. Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

The development of multiobjective location (MOL) models presents planners and decision makers with the range of alternatives or options that are available, illustrates the trade-offs that arise from differing emphases upon various objectives, and provides planners and decision makers who have differing viewpoints with illustrations of compromise solutions. MOL models are not generally used to make decisions or to arrive at optimal solutions. They are used to provide detailed information on non-inferior options are feasible, including quantitative information on trade-offs. They are flexible and responsive and can be repeatedly exercised using different objectives and constraints without extensive reprogramming or restructuring. The method described in this paper is a new tool developed by The Johns Hopkins University Applied Physics Laboratory that might be used to enable the environmental scientist to work with electric utility planners and provide useful input to the power plant process. It provides a coherent framework in which both environmental considerations and their cost implications may be explored for a large number of alternative policies.

25972 (LA—8278-MS) **Endangered species protection and water resource development.** Harrington, W. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 64p. NTIS, PC A04/MF A01.

The Endangered Species Act and its implementation are reviewed, with special attention given to the Act's recent Amendments. This Act has played a major role in litigation surrounding several recent water resource developments. A case study of one such, the Missouri Basin Power Project, is discussed. In addition to a short case history, issues covered include the following: the link between the Power Project and its impact on the endangered species, its effect on the distribution of water resurces, its effect on future development on the Platte River, and the extent to which a range of preservation options can be considered under the Act. Tentative general conclusions will be drawn concerning the flexibility of the Act, its cost effectiveness, and its implications for future water resource development.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 25957, 25972, 25982, 26074, 26075, 26734

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 25994

25973 **Department of Energy's approach to commercialization.** Gouraud, J. *Energy Technol. (Wash., D.C.);* **6**: 36-39(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

DOE's commercialization efforts relate to the Federal government's charge to assess energy technologies and help bring those that will be viable to the marketplace. DOE's role is to remove the economic and institutional barriers to permit and encourage private industry to take over. A list of promising technologies was assessed by a task force using matrix-management techniques, supplemented by outside opinions, to judge each on its readiness. Enhanced oil recovery, unconventional gas recovery, industrial atmospheric fluidized-bed combustion, and wood combustion were judged to have the greatest potential for supplying energy. A

position of Resource Manager was established to coordinate commercialization activities for each technology. (DCK)

25974 Towards global action for appropriate technology. Bhalla, A.S. (ed.). Elmsford, NY; Pergamon Press, Inc. (Sep 1978). 238p. (CONF-771279—).

From Expert meeting on international action for appropriate technology; Geneva, Switzerland (Dec 1977).

The Netherlands Government, in collaboration with the International Labor Office, convened a meeting in December 1977 at which individual experts and representatives of developing and developed countries as well as representatives of international organizations were invited to advise on the possibilities of organizing a better-coordinated international effort in the field of appropriate technology. The group formulated terms of reference for a team to study the feasibility of establishing a new international mechanism for the promotion of appropriate technology. The proposals of the feasibility team were based on extensive consultations in the first half of 1978 with authorities and experts in developed and developing countries as well as with the relevant staff of a selected number of agencies within the UN system. The revised discussion papers for the meeting and the proposals of the feasibility team are presented in this book. Part I, Concepts, Criteria, and Strategies, has two chapters; Part II, Existing Institutional Framework, consists of three chapters; and Part III, Global Action, has one chapter that presents the blueprint for global action.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 25345, 25362, 25387, 25430, 25446, 25886, 25888, 25896, 25903, 26081, 26734

25975 (EPRI-EA—1366) **Prototype analysis of EPRI R and D funding. Final report.** Judd, B.R.; Metcalfe, M.R.; Schaefer, J.C. (Applied Decision Analysis, Inc., Menlo Park, CA (USA)). Feb 1980. 85p. NTIS, PC A05/MF A01.

A first step was completed in the development of a quantitative framework to assist EPRI planners to analyze R and D budgets. A methodology was produced to evaluate benefits of different total annual funding levels. Part of EPRI's budget was analyzed to demonstrate the methodology. EPRI planners participated in the development effort. The project team used analytic models to describe relationships among factors in R and D decisions. These factors include funding, research achievements, utilization of research products, and benefits of utilization. Illustrative data were provided by the project team. Different measures of R and D benefit were evaluated, including future electricity costs and measures of economic welfare. These benefit measures serve different purposes, so no single measure was selected. Techniques for analyzing uncertainties were included. An example showed how benefits of current R and D funding are influenced by uncertainties in research achievements for coal and nuclear power generation technologies. The project team concluded that problems remain to be overcome as the methodology is developed further. These include obtaining reliable data and achieving realistic yet understandable models. Team members also believe, however, that the methodology potentially represents a valuable tool for organizing R and D planning information and for investigating benefits of different EPRI funding levels. 30 figures, 6 tables.

25976 (EPRI-WS—78-95, pp 4.51-4.76) **Integrating environmental considerations into system models: questions and examples.** Van Horn, A.J. Oct 1979.

From Workshop on integration of environmental considerations into energy-economic system models; Eastsound, WA, USA (17 Oct 1979).

Computer models are being used increasingly to evaluate energy systems for their future environmental impacts and economic implications. In seeking effective approaches to integrated system modeling, it is essential to raise questions about models in general and to examine current models and their applications. Questions are posed and observations provided and then examples based on experience with the Utility Simulation Model, a comprehensive assemblage of models developed by Teknekron to forecast the environmental and economic implications of investment and operating decisions made by electric utility firms are presented. A description of the model USM is given in detail. The USM consists of a number of interconnecting computer models and data bases that simulate decisions for system planning and operation, utility finance, and the operation of individual technical processes such as pollution control devices. The model is driven by a set of exogenous scenario elements that include electricity demand levels, financial market conditions, fuel prices and availabilities, advanced technology deployment, and environment regulations.

25977 What is the volume of government expenditure on nuclear energy. An analysis of statistical data for the Fed. Rep. of Germany, 1956-1979. Gries, W. (Deutsche Gesellschaft fuer Wiederaufarbeitung von Kernbrennstoffen m.b.H. (DWK), Hannover (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **24**: No. 8/9, 415-417(Aug-Sep 1979). (In German).

In the debate about the economics of nuclear electricity generation it is often argued that this source of power would lose its competitive edge over others if all government expenditures made to support nuclear energy were taken into account. The figure quoted for government funding in the Federal Republic of Germany from the beginning of nuclear power development in 1956 until 1979 is DM 25.6 billion. Analysis of the figures shows that the actual total funding volume is less than half this amount. This is due, above all, to the high percentage spent on the large nuclear research centers, which, however, are now involved in non-nuclear activities with up to, or more than, one third of their capacities. The level of government expenditure is reduced even further if basic research is regarded separately and only the use of nuclear energy for power generation and, in particular, the expenditures to be assigned to light water reactors are taken into account. (orig.).

25978 Nuclear power: the threat to personal freedom. White, R.G. (Council for the Protection of Rural England). *Nature (London);* **282**: No. 5741, 774-775(1979).

The inevitable implications on civil liberties of the UK government's proposal to expand the nation's nuclear capacity is discussed with especial reference to surveillance, venting and security needs and the costs incurred by the escalation in the manpower involved are considered.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 25255, 26058, 26059, 26060, 26061, 26062, 26084

25979 Overview of division of energy storage program, Department of Energy. Pezdirtz, G.F. *Energy Technol. (Wash., D.C.);* **6**: 896-903(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

A crucial role in the National Energy Plan will be played by the development of energy-storage technologies and their use in a variety of applications, such as power storage for utility load leveling and thermal storage for buildings and manufacturing processes. DOE programs encompass both stationary and mobile applications, many of which give near-term assistance to energy-conservation problems. Federal involvement is necessary because many of the technologies involve high-risk research and development investments which would otherwise slow market penetration. DOE-funded programs in central storage include compressed air, underground pumped hydro, battery packs, waste heat and coolness, lowlead hydroelectric generation of hydrogen, and customer storage studies. Work on dispersed storage technologies includes a variety of vehicle batteries, flywheels, and hybrid concepts for vehicles. 5 figures. (DCK)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 25866, 25919, 26078, 26079, 26080, 26081

25980 (CONF-7910151—1) **Evaluation procedures for industrial cogeneration utilizing alternate steam sources.** Melick, G.F.; Steiner, R.B.; Scott, D. (Stone and Webster Engineering Corp., Cherry Hill, NJ (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

From Industrial power conference; Cincinnati, OH, USA (21 Oct 1979).

The results are presented of a cogeneration feasibility study, utilizing alternate steam sources. The study considered sites which could serve four to six industrial complexes in the Gulf States Utilities service area. The sources of steam considered were conventional steam generators using oil or coal and advanced technologies such as high-temperature gas-cooled nuclear reactors (HTGR), consolidated nuclear steam supply (CNSS) using a light water reactor, fluidized-bed coal combustion, and coal gasification using conventional steam generators, combined cycles, and fuel cells. The scope of the study included selecting two preferred sites for cogeneration plants, developing and optimizing heat cycles, writing plant and equipment descriptions, determining capital and operating costs, evaluating alternatives, and drawing conclusions based on technical and economic factors.

CONSERVATION

REFER ALSO TO CITATION(S) 25346, 26045, 26046, 26051, 26054, 26055, 26056, 26070, 26074, 26075

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 25300, 25951, 25952, 25954, 25958, 25993, 25996, 25997, 26002, 26066

25981 (DOE/EIA—0201/9) **Qualitative assessment of the impact of energy demand-management programs. Volume 9. Energy policy study.** Rodekohr, M.; Carlin, J.; Hatcher, D. (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1980. 72p. NTIS, PC A04/MF A01.

This report presents a qualitative analysis of the impact of specific government actions on the demand for energy in the residential, commercial, industrial, and transportation sectors, as well as in renewable resources and load management. Several Federal energy programs are examined: those that attempt to alter the investment formula for producers or for consumers with respect to energy-consuming capital equipment; those that alter the market information structure; and those that alter the regulatory environment to increase market efficiency. Compared are a regulated energy market with price controls and demand-management programs, and an efficient energy market which lacks energy price controls and demand-management programs. The economic characteristics, costs and benefits, and theory of demand-management programs are discussed. A review of all the demand-management programs is considered.

25982 (DOE/EIA/CR—0456) **Documentation of Volume Three of the 1978 Energy Information Administration Annual Report to Congress.** (Kilkeary, Scott and Associates, Inc., Arlington, VA (USA)). 29 Feb 1980. Contract AC01-79EI10456. 325p. NTIS, PC A14/MF A01.

The purpose of the ARC78 forecasts and the ways in which they differ from those in the ARC77 are discussed. In a preliminary overview of the projection process, the relationship between energy prices, supply, and demand is addressed. Topics treated in detail include a description of energy-economic interactions, assumptions regarding world oil prices, and energy modeling in the long term beyond 1995. Subsequent sections present the general approach and methodology underlying the forecasts, and define and describe the alternative projection series and their associated assumptions. Short-term forecasting, midterm forecasting, long-term forecasting of petroleum, coal, and gas supplies are included. The role of nuclear power as an energy source is also discussed.

25983 (DOE/EV/10274—3) **Policy Analysis Screening System (PASS) demonstration: sample queries and terminal instructions.** (American Management Systems, Inc., Arlington, VA). 16 Oct 1979. Contract AC02-79EV10274. 47p. NTIS, PC A03/MF A01.

This document contains the input and output for the Policy Analysis Screening System (PASS) demonstration. This demonstration is stored on a portable disk at the Environmental Impacts Division. Sample queries presented here include: (1) how to use PASS; (2) estimated 1995 energy consumption from Mid-Range Energy-Forecasting System (MEFS) data base; (3) pollution projections from Strategic Environmental Assessment System (SEAS) data base; (4) diesel auto regulations; (5) diesel auto health effects; (6) oil shale health and safety measures; (7) water pollution effects of SRC; (8) acid rainfall from Energy Environmental Statistics (EES) data base; 1990 EIA electric generation by fuel type; sulfate concentrations by Federal region; forecast of 1995 SO_2 emissions in Region III; and estimated electrical generating capacity in California to 1990. The file name for each query is included.

25984 **Energy balances of OECD countries, 1974-1976.** Paris, FR; Organization for Economic Co-operation and Development (1978). 32p. (In English and French). OECD Publications Center, Washington, DC.

Detailed energy balance data are presented for solid fuels, crude oil and natural gas liquids, petroleum products, gas, nuclear power, hydro and geothermal, and electricity for the following: OECD total; OECD Europe; North America; EEC; Canada; US; Japan; Australia; New Zealand; Austria; Belgium; Luxembourg; Denmark; Finland; France; Germany; Greece; Iceland; Ireland; Italy; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland; Turkey; and UK. Additional data are tabulated on total energy requirements, net oil imports, and electricity generated (1961-1976).

25985 (LA—8266-MS) **Conventional fuel prices and future projections: data inputs for the LASL/UNM EASE II model.** Roach, F. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 117p. NTIS, PC A06/MF A01.

Conventional fuel prices paid by residential customers are developed for 223 locations in the contiguous United States. The fuel prices serve as a basic input to the Los Alamos Scientific Laboratory/University of New Mexico (LASL/UNM) solar economic performance model (EASE II). Average unit prices are constructed for the three principal fuels used in residential space heating: electricity, heating oil, and natural gas. For comparative purposes, these average unit prices are converted to their $/10^6 Btu equivalency. These prices represent residential costs in the late 1978/early 1979 time period. Procedures used in the construction of unit fuel prices are described in detail with major sources of information identified. Two series of price projections are made for each fuel for the years 1985 and 1990. These projections illustrate potential costs to residential customers. 6 figures, 15 references, 8 tables.

25986 **Uncertainty and the effect on planning.** Males, R.H. (Electric Power Research Inst., Palo Alto, CA). *Energy Technol. (Wash., D.C.);* 6: 249-255(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

Those involved in planning for future energy supplies must deal with the uncertainty factor, part of which is the uncertainty of demand, and the cost of planning errors. Demand forecasts cover a broad range because they are based on different assumptions of what will happen and how people will react and because consumption measurements are not accurate or consistent. The cost of underplanning is more complex and stressful - and more costly - than the cost of overplanning. An optimal curve for electrical system expansion is developed, using environmental, fixed, variable, and outage costs to show the relationship of uncertainty to cost. Four planning principles are derived from this, calling for a quantitative display of uncertainty, a policy of open technological options, flexibility, and a planning supply cushion. 6 figures. (DCK)

25987 **International Energy Agency workshops on energy supply and demand.** Paris, France; Organisation for Economic Co-operation and Development (1979). 502p. (NP—24412). OECD Publications and Information Center, Suite 1207, 1750 Pennsylvania Ave. NW, Washington, DC $30.00.

Papers presented at two workshops are gathered into three sections and a separate abstract was prepared for each section. Both workshops were held in Paris under the auspices of the IEA, the one on energy supply in November 1976 and the one on energy demand in December 1977. Papers (7) in th first section on energy supply are empirical in approach. The next two sections deal with energy demand, 6 papers emphasizing theoretical approaches and 7 others presenting empirical approaches.

25988 **Energy supply.** pp 9-215 of International Energy Agency workshops on energy supply and demand. Paris, France; Organisation for Economic Co-operation and Development (1979).

Seven papers are presented on energy supply, categorized as empirical. They are: Synfuel Supply Issues From the Commercial Perspective (New Kinds of Decisions) by B. Ball, Ball and Associates, Cambridge, MA; Coal Supply Prospects in the United States (An Appraisal of Current Knowledge) by R. Gordon, Pennsylvania State University; Canadian Frontier Regions Oil Supply Potential by C. Mattinson, Shell Canada Resources Ltd., Alberta, Canada; An Economic Analysis of British North Sea Oil Supplies by C. Robinson, University of Surrey, England; The Future Supply of Indigenous Oil and Gas in Western Europe (With Special Reference to the North Sea) by P. Odell, Erasmus University, Rotterdam, Netherlands; Spanish Oil Prospects by R. Querol, Hispanoil, Spain; and Stable Growth and Energy Strategy (Two Approaches) by T. Ikuta, Institute of Energy Ecobi Economics, Tokyo, Japan.

25989 **Theoretical approaches to energy demand.** pp 221-379 of International Energy Agency workshops on energy supply and demand. Paris, France; Organisation for Economic Co-operation and Development (1979).

Six papers are presented in this section, namely: Factor Markets in General Disequilibrium - Dynamic Models of the Industrial Demand for Energy by L. Waverman, University of Toronto, Canada; The Demand for Gasoline in the United States - A Vintage Capital Model by J. Sweeney, Stanford University, Palo Alto, California; Engineering and Econometric Approaches to Industrial Energy Conservation and Capital Formation - A Reconciliation by E. Berndt, MIT, Cambridge, MA; Methodology for Studying World Energy Demand by R. Eden, University of Cambridge, England; Structure and Technology As Determinants of Energy Demand in Post World War II Italy, O. Bernardini, Montedison, Milan, Italy; and Energy Balances and Electricity in Terms of Fuel Equivalents, with references to OECD Balances by J.R. Frisch, Electricite de France, Paris.

25990 **Empirical approaches to energy demand.** pp 381-501 of International Energy Agency workshops on energy supply and demand. Paris, France; Organisation for Economic Co-operation and Development (1979).

The seven papers included in this section are: Results of Policy Simulations to 2000 by J. Griffin, University of Houston, Texas; Energy Demand to 1990 in the European Community by C. Waeterloos, EEC Directorate-General for Energy, Brussels; Energy Demand Prospects in Non-OPEC Developing Countries by J.B. Choe, World Bank, Washington, D.C.; Latin American Energy and Oil - Present Situation and Prospects: an Overview by L. Sa Silva, Inter-American Development Bank, Washington, D.C.; Canadian Energy Demand Outlook 1985, and 2000 by A. Bain, Imperial Oil, Toronto, Canada; Development of Energy Consumption in Western Germany, 1973-1977, 1980, 1985, and 1990 by H. Kraft, MVW, Hamburg, Germany; and Energy Prospects for the Federal Republic of Germany by D. Schmitt, Cologne University, Germany.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 25287, 25430, 25444, 25445, 25446, 25960, 25961, 25981, 25995, 25998, 26044, 26046

25991 (DOE/EIA—0201/4) **State regulation of electric and gas utilities: energy policy study. Volume 4.** Taschjian, M.; Hewlett, J. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1980. 94p. NTIS, PC A04/MF A01.

State regulation of electric and gas utilities is examined. The concept of natural monopoly is reviewed, and alternative approaches to the problem are examined, using current economic literature. Private monopoly, public ownership, and regulatory intervention are compared as the chief alternatives. Various forms of regulatory intervention are discussed, ranging from franchise auction through rate-of-return regulation. The latter approach is then examned in detail, discussing the Averch-Johnson effect, regulatory lag, and the impact on technological choice and development of new technology. Alternative price structures are examined and contrasted with the free market case of an unregulated monopolist. The main conclusion is that current regulatory intervention appears to be the least desirable of the alternatives in terms of efficiency of resource use, price, output, and distribution of consumer surplus. 9 figures, 9 tables.

25992 (DOE/RG—0027) **Solar energy and renewable resources in relation to the 11 PURPA standards. Guideline No. 2.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Feb 1980. 72p. NTIS, PC A04/MF A01.

On June 20, 1979, the President directed the Department of Energy (DOE) to develop and publish within 120 days a voluntary guideline, applying specifically to solar energy and renewable resources, for the ratemaking and other regulatory policy standards established under Title I of the Public Utility Regulatory Policies Act of 1978 (PURPA). On October 12, 1979, the Department of Energy (DOE) issued a Notice of Proposed Voluntary Guideline and Public Hearings for Solar Energy and Renewable Resources Respecting the Federal Standards Under the Public Utility Regulatory Policies Act of 1978 (PURPA) (44 FR 60236, October 18, 1979). This Notice summarizes in the Preamble the public comments DOE received and presents the voluntary guideline in its final form as the Appendix hereto.

25993 **U.S. energy problems, challenges in the 1980s.** Sawhill, J.C. (Dept. of Energy, Washington, D.C.). *Energy User News;* **4**: No. 53, 22-23(31 Dec 1979).

The Deputy Secretary of Energy, John C. Sawhill, examined five U.S. energy problems and recommends taking the long view toward rethinking the way we derive and use energy. He identifies the political and supply instability of Mid-East oil, a growing world demand for oil, inadequate oil production by non-OPEC suppliers, and the shift in oil sales to inter-government and spot-market sales as the major problems. Policies to reduce oil dependence and a shift to more stable and secure energy supplies include a goal of reducing imports 50 percent by 1990 through a gradual decontrol of domestic crude oil combined with a windfall profits tax. Financial incentives to increase natural gas and coal production should be pursued along with programs to develop gasahol, solar energy, synthetic fuels, and nuclear power. These policies will be balanced with oil disincentives to decrease demand in all sectors. (DCK)

25994 **World energy prospectus: government views.** LeGassie, R. (Energy Technology for Planning and Analysis, Washington, DC). *Energy Technol. (Wash., D.C.);* **6**: 26-30(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

The near- and mid-term prospects for new energy technologies are such that a return to fair-market pricing and a better understanding of real life-cycle energy costs are essential. Government policies that encourage alternative energy sources are anticipated, but with the Federal government turning more in the direction of incentive and regulatory approaches and withdrawing from research and development. The probable areas for energy development are enumerated. A strategic analysis of the tradeoffs between energy price and supply security is needed to find the optimum import level. The higher cost of domestic technologies, for example, is the price required to lower import levels. A study of five Western countries found that a small change in price can lower imports by 40%. Policies designed to accelerate the rate at which new technologies emerge must also be examined to determine their overall impact. This varies for each country, but the base for all is found to be coal, nuclear, and energy efficiency and the major technical thrusts will be in oil recovery, synthetic fuels, and renewables (DCK)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 25118

COAL

REFER ALSO TO CITATION(S) 25244, 25255, 25280, 25287, 25298, 25953

PETROLEUM

REFER ALSO TO CITATION(S) 25288, 25292, 25296, 25297, 25298, 25299, 25300

25995 (ID—80-11) **Prospects for a stronger United States-Mexico energy relationship. Report to the Congress.** (General Accounting Office, Washington, DC (USA)). 1 May 1980. 63p. US General Accounting Office, Washington, DC.

Issues which have an impact on Mexico's petroleum production and export decisions and the effects of its policies on the US and on its own economic development are examined. Mexico's potential source of needed oil and gas to the US and to the world at large is reviewed. The following chapters are presented: Energy Relations Between the United States and Mexico; Search for a Proper US Energy Relationship with Mexico; Energy's Role in Mexico's Future; and Energy Policy Making in Mexico.

25996 (LBL—10248) **Material-flow data structures as a basis for energy information system design.** Krishnan, V.V.; Cahn, D.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 20p. (CONF-800529—3). NTIS, PC A02/MF A01.

From American Society for Information Service mid-year meeting; Pittsburgh, PA, USA (15 May 1980).

In efforts aimed at information system design to assist national energy decision making, we have analyzed the US petroleum supply and distribution system. The overriding goal was to develop data structures conducive to information system design; this led us to emphasize methodological uniformity and generalizability. Quantized petroleum flows among restricted channels in the distribution net form the basis of the data structure. The resultant vectorial representations provide a direct link between conceptual models of system function and information system implementations to capture them. Simultaneously, they ease otherwise difficult problems such as data validation and error isolation.

NATURAL GAS

REFER ALSO TO CITATION(S) 25288, 25298, 25299, 25305, 25306, 25312, 25991, 25995

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 25315

25997 (DOE/EIA—0183/20) **US shale oil forecasts, 1985-1995. Technical report.** Schramm, L.W. (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1980. 31p. Dep. NTIS, PC A03/MF A01.

This Technical Report provides forecasts of shale oil production until 1995 under low, medium and high world oil price scenarios shown in the 1978 Energy Information Administration, Annual Report to Congress. The methodology used is to estimate a point in time when shale oil will become competitive with imported oil, make allowance for the time required to prepare technology and build the initial plants, and estimate a rate of expansion for the industry. According to the forecasts, the assumed low world oil price trajectory would not provide any incentive to industry to build oil shale plants during the time frame considered, while the medium prices path would provide very little incentive, if any, before the early to mid 1990's. The assumed high world oil price, however, which rises rather rapidly throughout the forecast period, would

provide a moderately strong incentive by the mid 1980's. Initial decisions to build plants would be made soon after the incentive becomes apparent, but such plants would not be in production until several years later.

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 26084

25998 (DOE/RG—0032) **Draft regulatory analysis: Notice of proposed rulemaking for the allocation and pricing of gasohol.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. 71p. NTIS, PC A04/MF A01.

The three principal problem are as addressed are: how to price unleaded blend stock and gasohol; how blenders are to obtain unleaded blend stock to blend with ethanol to produce gasohol; and how gasohol suppliers may distribute gasohol to purchasers. The proposed pricing and allocation rules, if adopted as final rules, would be in effect for about a year, because the statutory authority for gasoline price and allocation controls has an expiration date of September 30, 1981. The principal issues addressed are: what volume of ethanol and gasohol production can be expected between now and the end of 1981; what prices these products are likely to reach, independent of the rule and its alternative; what effect the rule and its alternative may have on the price and distribution of ethanol and gasohol; and what effect the rule and its alternative may have on motor vehicle misfueling and competition in the motor gasoline industry. On supply issues, it is concluded that by December, 1981, ethanol and gasohol production should increase by a factor of 3 or 4 above present levels, enough to meet the President's goals, without requiring additional corn acreage or adversely affecting food production. Ethanol production should increase from its present level of about 92 million gallons per year (6062 B/D) to the 3, 4, and 7 hundred million gallons per year levels (20,000, 30,000, and 45,000 B/D) necessaryto produce gasohol at year-end rates of 200,000 B/D in 1980, 300,000 B/D in 1981 and 450,000 B/D in 1982. In 1980 gasohol will represent about 3.2 percent of the total gasoline market, and 7.9 percent of the total unleaded market. Gasohol should help extend, rather than adversely affect, unleaded supplies. 30 references, 8 tables.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 25975, 25991, 26066

25999 (DOE/EIA—198(79)IN) **National Electric Rate Book: Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 14 Jan 1980. 22p. GPO.

The National Electric Rate Book summarizes rate schedules for electric service sold to ultimate consumers by all privately- and publicly-owned electric utilities operating in urban areas within the United States. To be included, the utility must serve at least one community having a population of 2500 or more. The schedule summaries present classes of service, energy charges, and a description of the character of service. Rates given are for residential, commercial, and industrial customers who use electricity for lighting, heating, power, and other purposes. Fuel adjustments reported by utilities are included in a separate table. There are 50 sections to the rate book, one covering each of the States; Maryland and the District of Columbia are combined in one section. Each state section includes an index of communities and an index of utilities for which rate schedules have been summarized. Annual updates are published for each state on a rotating basis. This report covers the State of Indiana.

26000 (DOE/EIA—0198(79)IL) **National Electric Rate Book: energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 21 Dec 1979. 30p. GPO.

The National Electric Rate Book summarizes rate schedules for electric service sold to ultimate consumers by all privately- and publicly-owned electric utilities operating in urban areas within the United States. To be included, the utility must serve at least one community having a population of 2500 or more. The schedule summaries present classes of service, energy charges, and a description of the character of service. Rates given are for residential, commercial, and industrial customers who use electricity for lighting, heating, power, and other purposes. Fuel adjustments reported by utilities are included in a separate table. There are 50 sections to the rate book, one covering each of the States; Maryland and the District of Columbia are combined in one section. Each state section includes an index of communities and an index of utilities for which rate schedules have been summarized. Annual updates are published for each state on a rotating basis. This report covers the State of Illinois.

26001 (DOE/TIC—11193) **Some observations on the practice of capacity expansion in the electric utility industry.** Soyster, A.L. (Systemetrics, Inc., Blacksburg, VA (USA)). 15 May 1980. Contract EI-78-C-01-6242. 34p. NTIS, PC A03/MF A01.

This report describes and contrasts certain average practice methods used by electric utilities for planning capacity additions. The scope of this task is narrowed to those engineering elements of capacity planning for which uncertainty plays a crucial role. The point of view is that of an individual utility, one which must determine a sequence of capacity additions over time that ensures adequate supply at a reasonable cost. The main elements of capacity planning are: (1) load forecast; (2) existing system; (3) generation reliability; (4) production simulation; (5) investment analysis; (6) financial analysis; and (7) judgmental evaluation. The typical sequence of events that couple these elements together can be described roughly, as follows: (a) A utility forecasts its expected load over the next T years. (b) By one means or another, a list of alternative expansion plans is determined. (c) Each of the alternatives in (b) is subjected to analyses of types (3), (4), and (5). (d) The alternative plan which minimizes the total cost, while ensuring an adequate level of reliability, is then further analyzed from a financial point of view. (e) The alternative, or set of alternatives, that are consistent with current and projected financial policies are subsequently subjected to a broad set of qualitative considerations. These include siting issues, regulatory concerns and environmental impacts. The ultimate choice of a capacity expansion alternative is then made considering both the economic and non-economic factors.

26002 (EPRI-EA—1304) **Modeling and analysis of electricity demand by time-of-day.** Fazzolare, R.; Taylor, L.D. (Arizona Univ., Tucson (USA). Engineering Experiment Station). Dec 1979. 499p. (CONF-7806184—). NTIS, PC A21/MF A01.

From Modeling and analysis of electricity demand by time-of-day workshop; San Diego, CA, USA (11 Jun 1978).

This report includes several papers on modeling and forecasting electricity demands by time-of-day that were presented at a workshop in San Diego, June 11-14, 1978. The papers and the accompanying discussants' comments present a cross section of the state of the art in research on the responsiveness of electricity demands to time-of-day rates. Preliminary analyses of several residential peak-load-pricing experiments present diverse estimates of the responsiveness of household electricity demand to time-of-day prices. As yet, there are few results that are directly applicable to utility forecasting and planning, however these analyses undoubtedly lay the foundation for useful results in the near future. There is only a small amount of data and even less analysis on the price responsiveness of load patterns in the commercial and industrial sectors. The volume is concluded with several insightful commentators' overviews of where the state of the art is and where it ought to be extended.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 25280, 25473, 25862

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 26063

26003 (ORNL/CON—44) **User's guide to the ORNL commercial energy-use model.** Barnes, R.W.; Emerson, C.J.; Corum, K.R. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 59p. NTIS, PC A04/MF A01.

This report describes the computer code that is associated with the ORNL Commercial Energy Use Model. The model uses both economic and technological factors to forecast energy use, fuel expenditures, and capital costs. The model is disaggregated in that it forecasts annual commercial energy use for ten building types, five end uses and four fuel types. Recently, regionalization of the model has incorporated interregional variation in factors such as fuel price and climate. The model has been used for several sensitivity studies and is presently being used as a tool to analyze Federal energy-conservation programs.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 25992

SOLAR

REFER ALSO TO CITATION(S) 25550, 25552, 25553, 25555, 25556, 25557, 25559, 25568, 25599, 25600, 25616, 25696, 25698

GEOTHERMAL

REFER ALSO TO CITATION(S) 25823, 25825, 25828

OTHER

REFER ALSO TO CITATION(S) 25298, 25595, 25852, 26709, 26710

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

26004 (FE—2895-6) **Report on the MHD performance demonstration experiment, October 1, 1978-September 30, 1979.** Schmidt, H.J.; Starr, R.F.; Whitehead G.L.; Seiber, B.L.; Garrison, G.W.; Welch, J.L. (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Oct 1979. Contract ET-78-I-01-2895. 146p. NTIS, PC A07/MF A01.

The Arnold Engineering Development Center (AEDC) has been under contract since December 1973 to modify existing equipment and to design, fabricate, and install new hardware to perform an MHD Performance Demonstration Experiment. The objective of the experiment is to demonstrate that a generator simulating a commercial-sized device can convert 16 to 18% of the available thermal energy into electric power. This report describes the fabrication, installation, and testing of the hardware for this experiment during the period from October 1, 1978 to September 30, 1979. In the past year, fabrication and assembly of the magnet were completed, the diffuser was assembled, and the generator channel installation into the flow train was completed. Initial testing of the magnet alone was performed with the coils at room temperature, and the peak field achieved was 2.7 Tesla. In a subsequent test of the magnet cooldown system and procedures, the magnet coils were cooled to 160°K and a peak field strength of 2.9 Tesla was achieved at this condition. Testing of the completed MHD system under power-producing conditions at low magnetic field strengths was started. Approximately one megawatt (MW) of electrical power was produced during a 10-sec run with a mass flow of 45 kg/sec and a peak magnetic field strength of 1.5 Tesla.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 26004

26005 (FE—2215-13(Vol.2), pp 708-846) **Participation in US/USSR MHD Cooperative Program.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

This task was added during the third year of the contract to provide for consulting to DOE on technical aspects of the forthcoming U-25B tests under the US/USSR Open-Cycle MHD Cooperative Program. The scope was then extended to provide MIT with responsibility for a major US effort on analysis and dissemination of data obtained in the U-25B facility. The US team for the shakedown test conducted at IVTAN in December 1977 comprised MIT and ANL personnel under DOE leadership. MIT personnel also participated actively in the three subsequent tests of the U-25B carried out during 1978, with responsibility for leadership of the US teams for these tests being vested in the Argonne National Laboratory. The tests yielded a great deal of data on operation at high magnetic fields, up to 5 Tesla, and with appreciable levels of MHD interaction. However, the electrical output and the distribution of axial field within the channel have not been well modeled by the overall performance codes generally used in the interpretation of other MHD experiments. Thus, much of the effort on analysis and interpretation of the data has been concentrated on careful examination of the local electrical and fluid mechanical behavior in the channel. Some of the results of the data analysis have been included in the US/USSR Joint Reports, but additional detail is presented.

26006 (FE—2895-7) **MHD high performance demonstration experiment. Quarterly progress report, October 1, 1979-December 31, 1979.** (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Jan 1980. Contract ET-78-I-01-2895. 44p. NTIS, PC A03/MF A01.

The objective of this experimental research, started late in 1973, is to demonstrate the attainment of MHD performance on a sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is attainable. To perform the experiment, an existing facility at the Arnold Engineering Development Center (AEDC) was refurbished and the new systems required for performing the experiment have been designed and built. In particular, the largest systems which have required the greatest expenditure of resources are the generator channel and the 6 Tesla (T) cryogenically cooled magnet. The entire HPDE system is now complete and shakedown testing of the magnet and flow train have been completed. During the period between October 1, 1979, and December 31, 1979, operation of the HPDE system in the Faraday power producing mode has continued. A peak power of about 18 MW was produced with a magnetic field of 2.8 T. Significant results which were obtained involved a definition of the transverse voltage characteristics, including the voltage drop near the electrode walls, and a definition of the fluid flow through the channel and diffuser. Several operational problems were encountered including erosion of heat sink components of the burner and channel entrance and Hall potential shorting at the aft end of the channel and diffuser. Required hardware procurement and modification were initiated by the end of the quarter to solve these problems.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 26017

26007 (CONF-800617—4) **Char gasification and ash vaporization in single-stage and two-stage coal-fired MHD combustors.** Hastings, T.W.; Sarofim, A.F. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemical Engineering). 1980. Contract AC01-79ET15518. 8p. NTIS, PC A02/MF A01.

From 7. international conference on MHD electrical power generation; Cambridge, MA, USA (16 Jun 1980).

A computer model is presented for the simulation of coal combustion under conditions pertinent to single-stage and two-stage open-cycle MHD systems. The vaporization of mineral constituents is described by an external-diffusion controlled model, using empirical data for the effective vapor pressures. Chemical kinetics are included for the reactions of char with O_2, CO_2, H_2O, O, and OH. A parametric study of the effects of pressure, fuel/air equivalence ratio, and oxidant preheat temperature is used to illustrate tradeoffs between coal combustion efficiency, ash vaporization, and combustor residence time.

26008 (CONF-800617—5) **Development of super-hot-wall electrodes.** Pober, R.L.; Cannon, W.R.; Bowen, H.K.; Louis, J.F. (Massachusetts Inst. of Tech., Cambridge (USA)). 1980. Contract AC01-79ET15518. 9p. NTIS, PC A02/MF A01.

From 7. international conference on MHD electrical power generation; Cambridge, MA, USA (16 Jun 1980).

Quantitative formulae have been developed for determining the electrochemical stresses imposed on a slag covered electrode subjected to a modest current density. These formulae predict an approximately exponential decrease/increase in effective oxygen partial pressure with current density, thickness and conductivity of the cathode/anode slag. Based on these analyses and on tests performed in the MHD Simulation Facility at MIT, a super-hot-walled electrode, which operates at a surface temperature above that where stable slag layers form, is proposed. For super-hot-walled electrodes, the same formulae are applied to the electrode design to avoid high electrochemical stresses. Studies in the laboratory indicated that materials based on strontium zirconate-lanthanum strontium ferrite systems would perform well as MHD electrodes. Tests in the MHD Simulation Facility show clean-fired durability of those electrodes to be very good. The degradation rate is shown to be conductivity and time dependent. 19 figures.

26009 (EPRI-AP—1345) **Open-cycle MHD power conditioning and controll requirements definition. Final report.** Petty, S.; Williams, K. (Avco-Everett Research Lab., Everett, MA (USA)). Mar 1980. 70p. NTIS, PC A04/MF A01.

In this report a generic inverter configuration is defined, and the relevant characteristics of line- and forced-commutated inverters are compared and evaluated for their suitability for MHD power applications. The interface requirements of an MHD channel inverter-utility interactive system are defined, and a forced-commutated inverter meeting these requirements is described. The results of a set of tests using this inverter are described along with recommendations for future work in this field.

26010 (FE—1760-41) **Secondary combustor evaluation cell III tests at the University of Tennessee Space Institute.** Lanier, J.; Kuleszta, P.; Attig, R. (Tennessee Univ., Tullahoma (USA). Space Inst.). Jul 1979. Contract EX-76-C-01-1760. 41p. NTIS, PC A03/MF A01.

The magnetohydrodynamics (MHD) system at the University of Tennessee Space Institute (UTSI) R and D Facility is coal fired with seed mixed and fed with the coal. The coal is normally fired

with a stoichiometric ratio of about 0.85 resulting in combustible gases in the effluent. All slag is carried through the generator and the nozzle and in one of the test bays a cyclone is used downstream to remove most of the entrained slag. In order to complete combustion of the carbon monoxide and hydrogen remaining in the flue gases, a secondary combustor was designed, built and tested. This combustor was designed to complete combustion of carbon monoxide and hydrogen while producing nitrogen oxide (NO/sub x/) levels below EPA limits. Water cooled tube banks were also designed, built and installed downstream of the secondary combustor to cool the flue gases and collect ash deposits for examination. Several tests were carried out to determine the effect of operating varibles on: (a) the combustibles (primarily CO) remaining in the flue gases; (b) nitrogen oxide concentration; and (c) sulfur dioxide removal. Results are reported.

26011 (FE—2476-1) **Gaseous electrode development. Final report.** Jones, M.S. Jr.; Scannell, E.P.; Sathyanarayana, K.; Thiagarajan, V.; Mallavarpu, R.; Armstrong, A.J. (Reynolds Metals Co., Sheffield, AL (USA). Energy Conversion Div.). Dec 1979. Contract EX-76-C-01-2476. 106p. NTIS, PC A06/MF A01.

The purpose of the present study is to optimize the gaseous electrode for use in an MHD generator and to test this optimum configuration in an operating MHD channel. The arc gaseous electrode concept is based on the use of an arc source in the body of the MHD channel electrode, wherein the arc follows a helical path and generates a plasma which flows out of a long, thin slot cut parallel to the cylindrical annulus, to provide a low impedance path for the MHD current through the boundary layer so that electrode erosion due to arcing can be reduced. Bench-scale tests on the arc plasma source were conducted. The effect of the parameters such as magnetic field, yaw angle with respect to the magnetic field, electrode geometry, and arc cathode materials were studied. Based on these studies, an optimum design was selected for testing in the MHD channel. Tests were conducted with the arc gaseous electrode in the cathode wall of a diagonal conducting wall MHD generator at magnetic fields up to 3.83 Tesla, with a supersonic flow of combustion products seeded with 1.0 w/o of potassium. The measured MHD plasma conductivity varied between 12 and 22 S/m. Results are presented and discussed in detail. (WHK)

26012 (FE—2476-2) **Gaseous electrode development. Quarterly report, July1-September 30, 1979.** (Reynolds Metals Co., Sheffield, AL (USA). Energy Conversion Div.). Oct 1979. Contract EX-76-C-01-2476. 33p. NTIS, PC A03/MF A01.

The main goal in this project is to demonstrate the feasibility of using gaseous electrodes in an MHD channel and to determine the optimum conditions for their operation. Previous work on this program has established that, to meet such an objective, the gaseous electrodes must be designed using plasma sources that operate continuously and which show a promise of operating successfully in an MHD channel environment. A new approach to the gaseous electrode concept that appears to hold a high probability of success and has various options for implementation uses microwave generated plasma sources. Progress on the development and testing of this new approach is reported. (WHK)

26013 (FE—15529-2) **MHD electrode development. Quarterly report, January-March 31, 1979.** Sadler, J.W.; Bein, J.; Black, D.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). May 1979. Contract AC01-79ET15529. 186p. NTIS, PC A09/MF A01.

Zirconia based electrode compositions have been selected for inclusion in the up-coming non-slagging super-hot WESTF Test 42. Fabrication and processing details for these materials are presented. The hafnia based materials to be included in this test have not yet been identified by Battelle Northwest Laboratory. Results of slag compatibility tests for a number of candidate ceramic insulating materials are presented. These test results have been used to rank these materials as candidates for use under the slagging hot or non-slagging super-hot operating modes. Laboratory screening tests, including electrochemical and anode arc erosion tests, have continued. A comprehensive analytical model has been derived which permits detailed analysis of the role of slag properties as well as electrode-slag polarization on the nature of electrochemical reactions under hot slagging conditions. Anode arc erosion tests have been extended to provide preliminary data on the effect of potassium carbonate/slag versus potassium sulfate/slag mixtures on the arc erosion of copper and platinum clad copper anode samples. The results indicate increased arc damage for the sulfate/slag mixture. Test planning and detail experiment design activities have continued in support of the upcoming WESTF tests. Parametric analyses were completed to define electrode and insulator material coupons for WESTF Test 42/44, non-slagging super-hot operating mode; design activities in support of WESTF Test 43, Pt-Fe, were similarly completed.

26014 (PNL—2004-11) **Development, characterization and evaluation of materials for open cycle MHD. Quarterly report, June 1979.** Bates, J.L.; Marchant, D.D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. 28p. NTIS, PC A03/MF A01.

The objectives of this program are to develop, test, characterize, and evaluate materials for open-cycle, coal-fired MHD power generators. The specific immediate goals emphasize electrode and insulator materials, including: (1) testing and evaluation of the enhanced effects of alkali seed on materials in a dc electric field; (2) development and testing of improved electrodes and insulators with controlled microstructures, compositions and properties; and (3) characterization and evaluation of materials relating to both the US MHD Program and the US-USSR Cooperative Program for MHD power generators. Progress is reported.

26015 (PNL—2004-12) **Development, characterization and evaluation of materials for open cycle MHD. Quarterly report for the period ending September 1979.** Bates, J.L.; Marchant, D.D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Nov 1979. Contract EY-76-C-06-1830. 59p. NTIS, PC A04/MF A01.

The development of hafnium-rare earth oxides, with demonstrated potential for MHD hot electrode, continues at a high level. Procedures for fabricating high density ceramic compacts with uniform microstructures at temperatures below 1875K for three compositions have been developed. Bars of these materials are being fabricated for testing in the Westinghouse WESTF facility. Yttrium chromites, which have also shown potential for hot electrodes, are being fabricated into test bars by a commercial supplier. These materials are being prepared for testing in WESTF. The required electrical conductivity and thermal conductivity have been, and are being, measured for these electrode materials. The RFG air preheater refractory, tested in Montana State University's heat exchangers (Core # 1) has been characterized and evaluated. The potential mechanism for corrosive attack by the molten slag have been identified.

26016 **Method of foaming a liquid metal.** Fischer, A.K.; Johnson, C.E. (to Dept. of Energy). US Patent 4,183,744. 15 Jan 1980. Filed date 28 Jul 1978. 4p.

PAT-APPL-929,144.

The addition of a small quantity of barium to liquid metal NaK or sodium has been found to promote foam formation and improve bubble retention in the liquid metal. A stable liquid metal foam will provide a more homogeneous liquid metal flow through the channel of a two-phase liquid metal MHD power generator to improve operating efficiency.

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 26005, 26011

26017 (ARI-RP—43) **Characterization of open-cycle, coal-fired MHD generators. Ninth-tenth quarterly technical progress report, July 1, 1978-April 30, 1979.** Kolb, C.E.; Wormhoudt, J.; Yousefian, V.; Cheng, W.; Bien, F.; Martinez-Sanchez, M.; Silver, J. (Aerodyne Research, Inc., Bedford, MA (USA)). May 1979. Contract EX-76-C-01-2478. 100p. NTIS, PC A05/MF A01.

The successful design of full-scale open-cycle, coal-fired MHD generators for baseload electrical production requires a detailed understanding of the plasma chemical and plasma dynamic characteristics of anticipated combustor and channel fluids. This report documents progress in efforts to model negative ion formation and slag condensation effects on core flow conductivity, to improve the ability to sample and characterize laboratory produced coal combustion plasmas, and to measure mechanisms and rates of slag oxide condensation. A set of parametric calculations showing the influence of various input parameters on a nominal full-scale, supersonic generator system is also presented.

26018 (ARI-RP—46) **Characterization of open-cycle, coal-fired MHD generators. Eleventh quarterly technical progress report, May 1-July 31, 1979.** Kolb, C.E.; Wormhoudt, J.; Yousefian, V.; Cheng, W.; Bien, F.; Dvore, D.; Martinez-Sanchez, M. (Aerodyne Research, Inc., Bedford, MA (USA)). Aug 1979. Contract EX-76-C-01-2478. 88p. NTIS, PC A05/MF A01.

The successful design of full-scale open-cycle, coal-fired MHD generators for baseload electrical production requires a detailed understanding of the plasma chemical and plasma dynamic characteristics of anticipated combustor and channel fluids. The report documents the development of a diffusion controlled heterogeneous condensation model and channel heat loss model for incorporation into the PACKAGE code used to calculate core flow plasma properties and generator efficiency. PACKAGE calculations comparing realistic baseload subsonic and supersonic generator models are also presented. Progress on the refinement of a laboratory scale coal combustion plasma source and its associated molecular beam mass spectrometer diagnostic and diode laser absorption plasma temperature measurement systems is documented. Finally, progress on the development of a numerical model describing arc behavior in MHD electrode boundary layers is presented.

THERMOELECTRIC GENERATORS

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 26091, 26100

26019 (MMM—2331-0602) **Thermoelectric materials evaluation program. Technical summary report.** Hinderman, J.D. (Minnesota Mining and Mfg. Co., St. Paul (USA). Industrial Electrical Products Div.). Apr 1979. Contract EY-76-C-02-2331. 288p. NTIS, PC A13/MF A01.

Research progress on the thermoelectric materials evaluation program is reported covering the period January 1, 1976 to September 30, 1978. Topical reports are presented on (1) hot and cold end ΔT's, (2) hardware mobility, (3) p-leg sublimation suppression, (4) thermodynamic stability of p-legs, (5) n-leg material process improvements to reduce extraneous resistance, (6) n-leg cracking, (7) dynamic evaluation of converter, and (8) data base and degradation modes. Twenty attachments are included which present supporting drawings, specifications, procedures, and data. (WHK)

THERMIONIC CONVERTERS

MATERIALS, COMPONENTS, AND AUXILIARIES

26020 (LA-UR—80-1315) **Thermionic properties of the molybdenum boron system.** Storms, E.K. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800806—3). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The thermionic work function has been measured as a function of composition within the various two phase regions between Mo and MoB_2. Values at the low boron and high boron phase boundaries for the various compounds were obtained by extrapolation. The following effective work functions were obtained: Mo_2B (low boron) = 3.08 eV; Mo_2B (high boron) = 3.63 eV; α-MoB (low boron) = 3.38 eV; α-MoB (high boron) = 4.30 eV; β-MoB (low boron) = 2.83 eV; β-MoB (high boron) = 3.92; Mo_2B_5 (low boron) = 4.65 eV; Mo_2B_5 (high boron) = 3.85 eV; and MoB_2 (low boron) = 3.52 eV. Because the composition range of these compounds is very narrow, the work function is very sensitive to the composition within the single phase regions.

FUEL CELLS

26021 (EPRI-WS—78-135) **Proceedings of the DOE/EPRI workshop on molten carbonate fuel cells.** Appleby, A.J. (ed.). (Electric Power Research Inst., Palo Alto, CA (USA)). Nov 1979. Contract W-31-109-ENG-38. 218p. (CONF-7810130—). NTIS, PC A10/MF A01.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Separate abstracts were prepared for 11 of the 16 papers presented. Five papers were previously included in the data base. (WHK)

26022 (EPRI-WS—78-135, pp 23-31) **Keynote speech.** Broers, G.H.J. (State Univ., of Utrecht, Netherlands). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

A history of the development of the molten carbonate fuel cell from initial efforts in the late 19th and early 20th century, using carbon or coal fuel, to work in the speaker's laboratory and at the Institute of Gas Technology, Chicago during the 1960's is presented. Figures illustrate, in an evolutionary manner, progress in high temperative molten carbonate fuel cells. They should be contrasted with the designs and performances described in the workshop papers.

DESIGN AND DEVELOPMENT

26023 (DOE/ET/15440—1) **Development of molten carbonate fuel cell power plant technology. Quarterly technical progress report No. 1, October 1, 1979-December 31, 1979.** (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Mar 1980. Contract AC01-79ET15440. 80p. NTIS, PC A05/MF A01.

The overall objective of this 29-month program is to develop and verify the design of a prototype molten carbonate fuel cell stack which meets the requirements of 1990's competitive coal-fired electrical utility central station or industrial cogeneration power plants. During the first quarter, effort was initiated in all four major task areas: Task 1 - system studies to define the reference power plant design; Task 2 - cell and stack design, development and verification; Task 3 - preparation for fabrication and testing of the full-scale prototype stack; and Task-4 developing the capability for operation of stacks on coal-derived gas. In the system study task, a study baseline fuel cell system and module configuration were established. Studies to determine user requirements and to characterize the fuel cell power block and coal gasifier subsystems were initiated. Cell stack design was initiated with completion of preliminary design requirements for the cell cathodes. Laboratory tests were also initiated to identify alternative materials for separator plates, reactant manifold seals, and electrolyte tile fillers. A mechanical tape casting technique for producing 18 x 24 inch sheets of electrolyte matrix tape was successfully demonstrated in Task 3. In Task 4, theoretical and experimental studies were initiated to define the effects of known sulfur contaminants on cell performance. A literature survey was initiated to identify other possible contaminants. Planning and design efforts for construction of a mobile cell test unit were initiated. The mobile unit will be used to verify the molten carbonate cell's ability to operate on gasified coal by tests at a gasifier site.

26024 (EPRI-WS—78-135, pp 2.23-2.31) **Molten carbonate cell performance model.** Szymanski, S.T.; Kunz, H.R. (United Technologies Corp., South Windsor, CT). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Mathematical models have been developed to aid in the development of molten carbonate fuel cell stacks. These models have been found to result in good agreement with experimental data. Improvements are being made in the models as new experimental data become available. Mathematical models of electrodes and stacks have been used extensively in the development of fuel cell power plants. These models have been used for three primary reasons. First, they help to clarify the sources of the cell polarizations and aid in their minimization. Second, they enable the performance to be expressable in mathematical form as a function of operating variables to aid in the selection of optimum operating conditions. Third, they provide assistance in the actual design of fuel cell stacks because information becomes available with respect to such quantities as heat rejection profiles. Therefore, work is underway to develop a mathematical model for molten carbonate fuel cells.

26025 (EPRI-WS—78-135, pp 3.3-3.7) **Carbonate fuel cell stack design.** Harrison, J.W. (General Electric Co., Wilmington, MA). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

A utility-sized molten carbonate fuel cell stack is described incorporating a filter press design with controlled pressure loading and internal manifolds. The flow fields are arranged for counter-flow of fuel and oxidant streams. The power rating based on the ECAS performance goals would be in excess of one megawatt at 600 volts DC.

26026 (EPRI-WS—78-135, pp 3.24-3.30) **Cell package design using DIGAS cooling.** Maru, H.C.; Baker, B.S.; Dharia, D.J. (Energy Research Corp., Danbury, CT). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Various schemes for heat removal from MCFC stacks are examined. A DIstributed GAS (DIGAS) cooling scheme is proposed which provides a simple, inexpensive means for heat removal. This scheme utilizes cathode process gas as a cooling medium, but minimizes the direct contact with electrolyte by diverting a portion of the gas to a cooling plate placed between a group of cells. As a result, both the carbonate loss and the auxiliary power requirements are minimized. A further improvement is obtained if the corrugated cathode current collector design is modified and some of the current collector channels are used as cooling passages. The net result is a simplified, inexpensive current collector, elimination of the special cooling plate, and an extended cell life.

26027 (SAN—0115/105-1) **Direct electrochemical generation of electricity from coal. Report for the period 16 May 1977 to 15 February 1979.** Weaver, R.D.; Leach, S.C.; Bayce, A.E.; Nanis, L. (SRI International, Menlo Park, CA (USA)). 1979. Contract EY-76-C-03-0115-105. 151p. NTIS, PC A08/MF A01.

The second phase of the investigation of the feasibility of the coal/air fuel cell is summarized. The major subjects discussed are: (1) anode fabrication: results of fabrication of anodes from coal are presented with characterization data and two methods of fabrication; (2) cell design: some of the factors influencing cell design are discussed; (3) kinetic studies: the factors influencing the voltage-current behavior of the carbon anode are investigated. Detailed results are presented; (4) cathode studies: early results of materials selection for the air cathode are presented; stainless steel is a candidate material; (5) thermal evaluation of a total power plant: the overall thermal efficiency of a nonoptimized plant is calculated and presented. The results indicate a nonpolluting process equivalent to or exceeding present day thermal efficiencies. Details of the calculations are presented; (6) technoeconomic analysis of 151 MW plant: conservative analysis for a plant with carbon pellet anode feed and

bottoming thermal recovery indicates an overall efficiency of 53.3 percent and a cost of $758 per kilowatt (638 MW plant, 1978 dollars). This cost is below competing molten carbonate systems using gaseous anode feed. Details of the analysis are presented.

26028 (SAN—1735-4) **Fuel cell research on second-generation molten-carbonate systems. Project 9105 final technical report, 1 October 1977-30 September 1978.** (Institute of Gas Technology, Chicago, IL (USA)). Apr 1979. Contract EM-78-C-03-1735. 271p. NTIS, PC A12/MF A01.

The objectives of the program were to (a) develop fuel cell components with improved performance and endurance and to (b) investigate, develop, and test cost-effective processes for electrolyte powder preparation and electrolyte tile fabrication. The effort was divided into three tasks: (1) Cell and component development - improved components and cost-effective fabrication processes were developed. This included developing stable anode structures and improved electrolyte structures. (2) Fuel cell electrolyte optimization - new melt compositions were tested in laboratory-scale cells. Supporting information necessary for electrolyte selection and for understanding the processes occurring in these systems was obtained by developing models to describe cell performance and by electrode kinetic measurements. (3) Cell operation at high pressure - the system was operated at high pressure to identify and provide solutions to cell-decay mechanisms. The anode developmental work focused on using nickel- and cobalt-based structures containing additives to inhibit sintering. A singificant experimental effort was devoted to defining the processing parameters necessary for producing acceptable electrolyte powders by an aqueous slurry technique. Potentially cost-effective tile manufacturing processes using the powders produced by the aqueous slurry process were identified in a cooperative effort with Coors Porcelain Co. Efforts to optimize the electrolyte composition focused on identifying the rates of fuel oxidation as a function of anode material, temperature, carbonate composition, and gas composition, and the development of mathematical models for the prediction of fuel cell performance as a function of various system operating parameters.

26029 (SAN—11276-2) **Fuel cell research on second-generation molten-carbonate systems.** (Institute of Gas Technology, Chicago, IL (USA)). Dec 1979. Contract AC03-78ET11276. 116p. NTIS, PC A06/MF A01.

The program emphasis focuses on identifying solutions to tile failure caused by thermal cycling, developing cost-effective cell components (primarily the bipolar cell separator plate), and determining the performance and endurance characteristics of baseline and newly developed cell components. Structural analysis of the cell package showed that electrolyte tile cracking caused by thermal cycling can be greatly reduced by reducing the thermal expansion difference between the cell separator plate and the electolyte tile and by reducing the ratio of the separator plate thickness to the electrolyte tile thickness. The feasibility of this analytical modeling approach was demonstrated by the good agreement betwen experimentally determined cracking behavior and that predicted by the structural models developed. Further verification is planned for the next quarter. Mechanical property measurements continued to be made on a variety of electrolyte tile compositions. The tile microstructure (agglomerate size and $LiAlO_2$ distribution) continued to strongly affect the tile strength. Carbonate composition were identified that matched more closely the thermal expansion of the metallic cell components. Cell testing of these compositions is showing good performance. A potentially cost-effective method of fabricating electolyte tiles and electrodes using the tape-casting method was demonstrated. In addition, good powder quality was achieved using the spray-drying technique for electrolyte powder preparation. Although further development is required to obtain acceptable cell components, initial results appear quite promising. Bench-scale cells (94-cm^2) using 10-mil sheet metal corrugated bipolar plates were developed and successfully operated.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 26028

26030 (EPRI-WS—78-135, pp 2.5-2.14) **Development of mathematical models to predict fuel cell performance.** Selman, J.R. (Illinois Inst. of Technology, Chicago); Sampath, V.; Sammells, A.F. Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

The performance of scaled-up (100-cm^2) fuel cells with cross-flow of fuel and oxidant has been modeled using the polarization characteristics of small-scale (3-cm^2) fuel cells. The model also yields the two-dimensional (superficial) current distribution. The performance predicted by the model approximates to within 4% the experimental data if a suitable average value is assigned to the effective cell impedance. The latter depends on the inlet gas composition but does not vary much with the current; its value may be estimated from small-scale cell data. Carbon monoxide conversion contributes appreciably to the performance of low-Btu cells; it tends to make the current distribution less uniform. The presence of methane must be considered in pressurized cells but it does not appear to be significantly reformed. The relative contributions of mass-transfer and kinetic resistance to the cell impedance are discussed in light of recent experimental results.

26031 (EPRI-WS—78-135, pp 5.21-5.32) **Molten carbonate cell sulfur tolerance.** Smith, S.W.; Bregoli, L.J.; Vogel, W.M. (Unted Technologies Corp., South Windsor, CT). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Extensive studies were performed on the effect of hydrogen sulfide in the fuel gas on molten carbonate cell performance. The hydrogen sulfide was found to react with the electrolyte and result in large performance losses if present at a level of only a few ppm. Provisions for sulfur removal must be made in molten carbonate power plants if they are to operate on sulfur-bearing fuels.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 25128, 25168, 25169, 26027, 26028, 26029

26032 **Cold formed ceramic fibers.** Morse, T.F. US Patent Application 061,151. [nd]. 18p.

Apparatus and method for cold forming polymeric-bound metal composition fibers by the use of a metal or metal oxide powder of the desired metal composition material, a polymeric composition, and a solvent for the polymeric composition. Polymeric-bound fibers are formed by rapid evaporation of the solvent from a one micrometer or less extrusion of the slurry. Thereafter, metal or metal oxide fibers are formed by sintering the polymeric-bound fibers. Products of this process include molten carbonate fuel cell tile.

26033 (EPRI-EM—1286) **Ac/dc power converter for batteries and fuel cells. Annual report.** Rosati, R.W.; Peterson, J.L.; Vivirito, J.R. (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Dec 1979. 211p. NTIS, PC A10/MF A01.

The leading commutating circuit options for an advanced self-commutated-type power converter were tested and analyzed by computer simulation. An analytical and experimental evaluation of advanced commutation circuits, an evaluation of alternative advanced bridge designs, selection of the most desirable conceptual design, and the development of a mathematical model of converter response are described. Experimental data and preliminary converter specifications are contained in the appendixes.

26034 (EPRI-EM—1333) **Assessment of sulfur removal processes for advanced fuel cell systems.** Lorton, G.A. (Braun (C.F.) and Co., Alhambra, CA (USA)). Jan 1980. 156p. NTIS, PC A08/MF A01.

This study consisted of a technical evaluation and economic comparison of sulfur removal processes for integration into a coal gasification-molten carbonate (CGMC) fuel cell power plant. Initially, the performance characteristics of potential sulfur removal processes were evaluated and screened for conformance to the conditions and requirements expected in commercial CGMC power plants. Four of these processes, the Selexol process, the Benfield process, the Sulfinol process, and the Rectisol process, were selected for detailed technical and economic comparison. The process designs were based on a consistent set of technical criteria for a grass roots facility with a capacity of 10,000 tons per day of Illinois No. 6 coal. Two raw gas compositions, based on oxygen-blown and air-blown Texaco gasification, were used. The bulk of the sulfur was removed in the sulfur removal unit, leaving a small amount of sulfur compounds in the gas (1 ppMv or 25 ppMv). The remaining sulfur compounds were removed by reaction with zinc oxide in the sulfur polishing unit. The impact of COS hydrolysis pretreatment on sulfur removal was evaluated. Comprehensive capital and O and M cost estimates for each of the process schemes were developed for the essentially complete removal of sulfur compounds. The impact on the overall plant performance was also determined. The total capital requirement for sulfur removal schemes ranged from $59.4/kW to $84.8/kW for the oxygen-blown cases and from $89.5/kW to $133/kW for the air-blown cases. The O and M costs for sulfur removal for 70% plant capacity factor ranged from 0.82 mills/kWh to 2.76 mills/kWh for the oxygen-blown cases and from 1.77 mills/kWh to 4.88 mills/kWh for the air-blown cases. The Selexol process benefitted the most from the addition of COS hydrolysis pretreatment.

26035 (EPRI-WS—78-135, pp 4.5-4.12) **Electrolyte structures for molten carbonate fuel cells.** Kinoshita, K. (Argonne National Lab., IL). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

A variety of synthesis methods were examined to obtain pure phases of $LiAlO_2$ with surface areas of 5 to 80 m^2/g. Particle size

analyses showed that, in general, the $LiAlO_2$ samples had a bimodal particle-size distribution. Thermal stability studies of $LiAlO_2$ in the presence of Li_2Co_3-K_2CO_3 at 650°C indicated that α-$LiAlO_2$ is not a desirable allotrope for use in molten carbonate fuel cells. At 650°C, β-$LiAlO_2$ remained unchanged with respect to particle-size distribution and allotrope, but transformed to γ-$LiAlO_2$ accompanied by particle growth at 700°C. No change in allotrope was observed when γ-$LiAlO_2$ was tested for 1000 h at 650°C in the electrolyte tile of a molten carbonate fuel cell. Experimental evidence gathered from fuel cell and laboratory pot tests indicates that the allotropic transformation and surface-area loss of $LiAlO_2$ appears to be less rapid in gas environments containing CO_2.

26036 (EPRI-WS—78-135, pp 4.26-4.30) **Electrode materials.** Dharia, D.; Kinnibrugh, D.; Patel, P.; Pigeaud, A. (Energy Research Corp., Danbury, CT). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

A higher surface area nickel-cobalt powder was prepared through the steps of co-precipitation and spray drying to obtain a fine particle hydroxide mixture which was then decomposed and reduced in the presence of hydrogen. Anodes sintered from this powder displayed improved performance and stability. Post-test measurements on a 3300 hour test (which was voluntarily terminated) revealed almost the same thickness, porosity, mean pore size and surface area as those of the initial anode structure. Cathode compatibility has been improved both with respect to performance and mechanical strength. Furthermore, the electrode sintering procedures have also been scaled to manufacture 1800 sq cm plaques.

26037 (EPRI-WS—78-135, pp 4.31-4.39) **Materials selection and problems for molten carbonate fuel cells.** Rapp, R.A. (Ohio State Univ., Columbus, OH). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Alloys selected for the fabrication of components in the molten carbonate fuel cell must generally resist oxidation and carburization in the electrode gases, and, eventually resist sulfidation upon the use of coal-derived fuels. Where the contacting component surfaces are required to pass the cell current, the highly conductive Cr_2O_3 protective oxide film is desired; but in the wetseal area, an Al_2O_3 scale or coating has demonstrated the best corrosion resistance. A local electrochemical cell existing where the contact between the bipolar separator plate and the electrolyte seals the anode gas from the surrounding air represents the worst corrosion problem in the sulfur-free cell. Iron-base alloys are more susceptible to carburization in the anode gas than nickel-base alloys, but the latter may form liquid nickel sulfide in coal-derived fuels. The potential loss of protection on the cathode side of the separator plate resulting from hydrogen diffusion through the plate does not seem to represent a serious problem. But the hot corrosion of alloys beneath a thin fused electrolyte film present generally in the electrode chambers is a problem which requires some specific study.

APPLICATIONS

REFER ALSO TO CITATION(S) 25866

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

26038 (EPRI-WS—78-135, pp 1.21-1.34) **Electrochemical oxidation of H_2 and CO in fused alkali metal carbonates.** Vogel, W.M.; Bregoli, L.J.; Smith, S.W. (United Technologies Corp., South Windsor, CT). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

The H_2/H_2O and CO/CO_2 reactions in molten carbonates can be written as (1) $H_2 + CO_3/sup =/ = H_2O + CO_2 + 2e^-$ and (2) $CO + CO_3/sup =/ = 2CO_2 + 2e^-$. The four gas pressures are interrelated by the shift reaction, and one cannot vary the individual gas pressures independently of each other. However, with proper precautions (avoidance of carbon formation, equilibration of gases prior to entering the electrochemical cell) the o.c.p. agrees accurately with the (equal) thermodynamic potentials of reactions (1) and (2). In the present study these precautions were taken. Furthermore, all gas compositions were such that the equilibrium methane pressures at operating conditions were negligible. It is the purpose of this study to obtain more information about the roles of reactions (1) and (2) in the overall process of oxidizing H_2 - containing gases, to study the complex diffusion overvoltage, and to confirm previous findings that reaction (1) proceeds with negligible activation polarization on a variety of metals. The experimental procedures and results are described.

26039 (EPRI-WS—78-135, pp 1.35-1.42) **Cathode chemistry and kinetics.** McHardy, J. (EIC Corporation, Newton, MA). Nov 1979.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

Oxygen reduction at the cathode of the molten carbonate fuel cell takes place by the reaction: $1/2O_2 + CO_2 + 2e^- \rightarrow CO_3/sup =/$. The inetics of the reaction appear to depend on the electrode material but only Au electrodes have been used for mechanistic studies. The results on smooth Au electrodes reveal that melt composition strongly affects both the mechanism and the rate of O_2 reduction. In mixed alkali carbonate melts, O_2 reduction proceeds kin 2 waves. The first (low eta) wave involves the reduction of peroxide ions formed by the equilibrium: $1/2\ O_2 + CO_3/sup =/$ reversible $O_2/sup =/ + CO_2$. The second (high eta) wave involves the reduction of superoxide ions formed by the equilibrium: $3/2\ O_2 + CO_3/sup =/$ reversible $2O_2^- + CO_2$. Only when both waves occur at low overpotentials can the full inventory of dissolved oxygen be utilized in the cathode reaction.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 25306

BUILDINGS

REFER ALSO TO CITATION(S) 25663, 25919

26040 (CONF-791232—, pp 191-201) **Building heating and cooling applications thermal energy storage program overview.** Eissenberg, D.M. (Oak Ridge National Lab., TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Plans are being developed for a comprehensive thermal energy storage technology and development program covering building heating and cooling applications in the residential and commerical sectors. Three elements have been identified to undergo an Applications Assessment, Technology Development, and Demonstration. The element receiving primary emphasis is the Utility Load Management TES Application where the stress is on the customer side of the meter. A second element involves improved and advanced thermal storage subsystems for space conditioning. The third element is Conservation by means of increased thermal mass within the building envelope and by means of low-grade waste heat recovery.

26041 (CONF-791232—, pp 203-211) **Subcontracted activities related to TES for building heating and cooling.** Martin, J. (Oak Ridge National Lab., TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Elements of the DOE/STOR program on Thermal Energy Storage for building heating and cooling and progress in this research are reported. Thermal energy storage for utility load management, for solar applications and for conservation is included. The status of each project on heat storage materials and equipment is outlined. (LCL)

26042 (CONF-791232—, pp 213-222) **In-house activities related to TES for building heating and cooling.** Kedl, B. (Oak Ridge National Lab., TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

Activities at ORNL related to research on thermal energy storage (TES) equipment for use in heating and cooling buildings are outlined. This research involves development of a TES laboratory, a TES test facility, analytical modeling of phase-change materials, and thermal energy storage and transport in the earth for assisting heat pumps. The status of each of these projects is briefly reviewed. (LCL)

26043 (CONF-791232—, pp 297-305) **Simulation and evaluation of latent heat thermal energy storage heat pump systems.** Sigmon, T.W. (Research Triangle Inst., Research Triangle Park, NC). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

A computer model is being developed for the purpose of evaluating the performance of a number of latent heat Thermal Energy Storage (TES)/Heat Pump systems for residential heating and cooling applications. The basis for this evaluation will be system annualized life cycle cost. Annual system performance will be determined at various simulation sites across the continental United States using manufacturers performance data for the basic heat pump components and the computed performance characteristics of a simplified TES subsystem design. The systems considered will be required to satisfy building heating and loads calculated using TRNSYS for different imposed electricity rate structures. Both the

TES/Heat Pump system performance and the load simulation model will be driven by hourly weather data provided by Sandia National Laboratory. By interfacing TES/Heat Pump performance with these thermal loads, optimum systems will be selected for each combination of site and rate structure considered.

26044 (DOE/CS/60474—T1) **Seminar on building codes and standards.** (National Conference of States on Building Codes and Standards, Inc., McLean, VA (USA)). 1980. Contract FG01-79CS60474. 133p. NTIS, PC A07/MF A01.

A seminar was conducted for state building code officials and state energy officials to discuss the following: status of the states regulatory activities for energy conservation standards for buildings; the development, administration, and enforcement processes for energy conservation standards affecting new construction; lighting and thermal standards for existing buildings; status of the development and implementation of the Title III Program, Building Energy Performance Standards (BEPS); and current status of the State Energy Conservation Program. The welcoming address was given by John Wenning and the keynote address was delivered by John Millhone. Four papers presented were: Building Energy Performance Standards Development, James Binkley; Lighting Standards in Existing Buildings, Dorothy Cronheim; Implementation of BEPS, Archie Twitchell; Sanctions for Building Energy Performance Standards, Sue Sicherman.

26045 (LBL—8671) **Can polarized lighting panels reduce energy consumption and improve visibility in building interiors.** Berman, S.; Clear, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 73p. (EEB-L—79-05). NTIS, PC A04/MF A01.

The lighting and vision literature, materials on management science and the reflectivity of surfaces are reviewed. The analysis emphasized the connection between lighting design and productivity. It is concluded that polarizing panels should be included among the alternatives normally considered by the lighting designer to utilize energy more efficiently than normal general lighting systems using standard prismatic or diffusing panels. A lighting design using polarizing panels might use 1/4 to 1/3 less energy than a reference system using standard prismatic panels without compromising function. The estimate of the potential energy savings available with polarizing panels is based on the estimate of their efficiency at producing Equivalent Spherical Illumination (ESI). ESI combines the effects of luminance and contrast into a single figure of merit for visibility. A short history and some background of ESI and a discussion of the measured reflectivities of paper and pencil on paper are presented. These data are used in ESI calculations. The problems and limitations of evaluating lighting systems strictly in terms of ESI per watt (or dollar) are discussed. An attempt was made to evaluate polarizing panels in terms of the factors discussed. Additional information is provided in 4 appendices.

26046 **DOE building energy performance standards.** Savitz, M.L. *Energy Technol. (Wash., D.C.);* **6**: 445-450(Apr 1979). (CONF-790213—).

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

Energy efficiency is a new factor in building codes, which have historically stressed health and safety, and are now required to include energy performance standards for new residential and commercial buildings. Changes in the laws that mandate Federal and state agencies to devise and implement building performance standards are reviewed and summarized. Weaknesses in the standards and points of disagreement are noted. A comparison of past and current issues indicates that the concept of a national building code and the front-end costs of efficiency standards are no longer major issues. The issues of climatic variations and implementation costs are not resolved. (DCK)

26047 **Dwellings equipped with natural airconditioning installations.** Trombe, F.; Michel, J. (to Agence Nationale de Valorisation de la Recherche (Anvar)). US Patent 4,111,359. 5 Sep 1978. Priority date 28 Oct 1975, France, 10p.

The installation comprises at least one inclined thermal enclosure, forming all or part of the roofing of the dwelling, bounded by an inner roof element, essentially constituted by a collector material of very low thermal mass, absorbing radiation of the solar radiation type of wave length comprised between 0.25 and 4 microns. An outer covering element also of very low thermal mass is essentially constituted by a material, preferably transparent to solar radiation and behaving as an opaque body to infra-red radiation of wave length comprised between 4 and 30 microns and so capable of emitting this radiation. This outer covering element has water and air sealing properties. This thermal enclosure is connected at its upper part to an upper duct forming a chimney directed upwards and provided with a closure member and, at its lower part, to a lower duct directed downwards and opening into the dwelling through at least one orifice. This thermal enclosure is connected at its upper part to a circulation duct opening into the dwelling and provided with a closure member in the vicinity of its opening.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 25689, 25717, 25741, 25924, 26322

26048 (CONF-791232—, pp 271-276) **Crawl space assisted heat pump.** Ternes, M.P. (Oak Ridge National Lab., TN). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

A variety of experiments and simulations are currently being designed or are underway to determine the feasibility of conditioning the source air of an air-to-air heat pump using stored ground heat or cool to produce higher seasonal COP's and net energy savings. The ground would condition ambient air as it is drawn through the crawl space of a house. Tests have been designed to evaluate the feasibility of the concept, to determine the amount of heat or cool available from the ground, to study the effect of the system on the heating and cooling loads of the house, to study possible mechanisms which could enhance heat flow through the ground, and to determine if diurnal temperature swings are necessary to achieve successful system performance. All studies are currently operating or will be operational by the end of 1979.

26049 (CONS—5142-T1) **Economic impact study of consumer product efficiencies. Final report.** (Chase Econometric Associates, Inc., Washington, DC (USA)). 30 May 1980. Contract EM-78-C-01-5142. 13p. NTIS, PC A02/MF A01.

The economic impact study of household appliance efficiencies is briefly reported. Task I, Direct Impact on Industry, contains 4 subtasks: materials, labor inputs, energy inputs, and investment. Task II, Direct Impact on Consumers, contains 3 subtasks: life-cycle cost to the consumer, usage patterns, and long-term demand forecast and analysis. The 2 subtasks in Task III, Energy Savings and Impact on Utilities, are residential energy savings and cost and impact on utility generating capacity.

26050 (LBL—10163) **Infiltration-pressurization correlation: simplified physical modeling.** Sherman, M.H.; Grimsrud, D.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 45p. (CONF-800635—1). NTIS, PC A03/MF A01.

From Conference of the American Society of Heating, Refrigeration and Air Conditioning Engineers; Denver, CO, USA (22 Jun 1980).

A model is presented for predicting air infiltration that eliminates many site-specific parameters normally required. The only information necessary is the geometry and leakage of the structure. The leakage quantities, expressed in terms of effective areas, are total leakage area and the leakage areas of the floor and ceiling. Weather parameters are mean wind speed, terrain class, and average temperature difference. The model separates the infiltration problem into two distinct parts: stack and wind-regimes. Each regime is treated independently; the transition between them is sharp. The model has been tested with data from several sites, differing in climate and construction methods.

26051 (ORNL/CON—48) **ACES 1979 capabilities and potential.** Minturn, R.E.; Abbatiello, L.A.; Nephew, E.A.; Baxter, V.D. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 59p. NTIS, PC A04/MF A01.

The state of technological development of ACES as of late 1979 is reviewed, and the results of two year's operation of the ACES in the Knoxville TECH complex are presented. An assessment of the technical and economic feasibility of the ACES concept based both on field results and on analytical calculations using a computer model of ACES performance and economics applied to 115 US cities is made. Areas needing further attention, especially with regard to capital cost reductions, are described.

26052 (ORO—5552-T9) **Improving the efficiency, safety and utility of woodburning units. Special creosote report.** Juger, S.J.; Maxwell, T.T.; Dyer, D.F.; Maples, G. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 15 Dec 1979. Contract EC-77-S-05-5552. 150p. NTIS, PC A07/MF A01.

This study was undertaken to determine the amount of creosote formed by a woodburning stove under various test conditions. Eighteen different tests were performed using three different types of wood (hickory, oak, and yellow pine), each with three different geometries. Tests were also performed using different moisture levels. To carry out the study, a special double wall stainless steel test chimney was constructed. A spectrophotometer was used to determine the relative concentration of the creosote-water solution. The wood type, moisture content and geometry did affect the creosote formation by the stove used in these tests. Wet wood produced more creosote than fire brands. Fire brands with larger piece sizes produced more creosote than the standard brands. Hick-

ory generated more creosote than oak. Oak generated more creosote than yellow pine.

26053 Levels and determinants of household insulation activity. Smiley, R. (Cornell Univ, Ithaca, NY). *Energy (Oxford);* 4: No. 6, 1087-1098(Dec 1979).

This paper provides evidence of current levels of household insulation, including storm windows and storm doors. A logistic probability model is used to determine the effect of heating fuel price, climate, and household characteristics (such as age of head and income) on the likelihood that a household will be well insulated or will intend to add insulation in the near future. Households heated by individuals under 50 years of age are better insulated, as are households with annual income greater than $20,000. Middle income families ($15,000-30,000/yr) are the most likely to plan to add insulation, while low income families are least likely. Households with a head over 65 years of age are less likely to plan to add insulation. These findings, in addition to evidence concerning households which are currently poorly insulated and do not plan to add insulation, are used to recommend modification of recently passed energy legislation. 7 refs.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

26054 (LBL—10475) **Hospital ventilation standards and energy conservation: chemical contamination of hospital air. Final report.** Rainer, D.; Michaelsen, G.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 56p. NTIS, PC A04/MF A01.

In an era of increasing energy conservation consciousness, a critical reassessment of the validity of hospital ventilation and thermal standards is made. If current standards are found to be excessively conservative, major energy conservation measures could be undertaken by rebalancing and/or modification of current HVAC systems. To establish whether or not reducing ventilation rates would increase airborne chemical contamination to unacceptable levels, a field survey was conducted to develop an inventory and dosage estimates of hospital generated airborne chemical contaminants to which patients, staff, and visitors are exposed. The results of the study are presented. Emphasis is on patient exposure, but an examination of occupational exposure was also made. An in-depth assessment of the laboratory air environment is documented. Housekeeping products used in survey hospitals, hazardous properties of housekeeping chemicals and probable product composition are discussed in the appendices.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 26003

26055 (ORNL/CON—39) **Energy and cost analysis of commercial building shell characteristics and operating schedules.** Johnson, W.S.; Pierce, F.E. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 68p. Dep. NTIS, PC A04/MF A01.

Eight prototypical commercial buildings were considered, and estimates of the energy savings realized from various conservation measures are presented. For each of four building types (hospital, office, educational, and retail) two building designs representative of both pre- and post-embargo construction were analyzed. The ongoing program at Oak Ridge National Laboratory aims to develop an engineering-economic model to forecast annual energy use in the US commercial sector. This particular study was undertaken to define relationships among energy-conservation measures, energy savings, and capital costs. Buildings were modeled and analyzed using NECAP (NASA Energy-Cost Analysis Program) based on hourly weather data in Kansas City (selected as typical of the entire country). Energy-conservation measures considered include night and weekend thermostat setback, reduction in ventilation, reduction in lighting, window alterations (shading, dual panes, and size reduction), economizer cycle, reset of supply temperature based on zone demand, and improvements in equipment efficiencies. Results indicate energy savings as a function of the capital cost of each energy-conservation measure for each of the eight buildings considered.

TRANSPORTATION

26056 (DOE/CS/50067—T1) **Shipper's guide to energy conservation.** Marien, E.J. (Wisconsin Univ., Madison (USA). Management Inst.). Jan 1980. Contract AC02-79CS50067. 84p. NTIS, PC A05/MF A01.

Recommendations are presented for money-saving tips for the shipping industry. Tips are included for the warehousing and distribution center management; transportation management; materials management for product packaging and shipping; and deployment and management of inventories sections in a firm.

RAILWAY

26057 (DOT-I—79-23) **Transit pricing techniques to improve productivity: proceedings of the March 1979 forum on recent advances and new directions.** (Public Technology, Inc., Washington, DC (USA)). Jun 1979. 71p. (CONF-7903118—). NTIS, PC A04/MF A01.

From Forum on transit pricing techniques to improve productivity; Virginia Beach, VA, USA (Mar 1979).

The papers presented at the forum covered the state-of-the-art in transit pricing policies and related issues and charted new directions to guide Urban mass Transportation Administration's transit pricing research and demonstrations program. The following papers were presented: Workshop I (Transit Fare Prepayment) The Importance of Pricing and Fare Innovations; Workshop II (Free and Reduced Fare Transit) Improving Transit Pricing, Transit Pricing Techniques; Workshop III (System and Market Analysis) Transit Fare Policy; and Workshop IV (Advances and New Directions) Subsidy Constraints and Transit Fares in a Proposition 13 Atmosphere.

26058 (SAN—1176-T2(Vol.1)) **Energy study of rail passenger transportation. Volume 1. Executive summary.** Henderson, C. (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 43p. NTIS, PC A03/MF A01.

The results and conclusions of the study by SRI treats the following topics: physical assets and services of rail passenger systems; energy demands and intensities; roles of local institutions; the industry future; and the role of the Federal government. Data reported were collected in 1976 and 1977, and in most cases, cover calendar year 1975.

26059 (SAN—1176-T2(Vol.2)) **Energy study of rail passenger transportation. Volume 2. Description of operating systems. Final report.** Henderson, C.; Ellis, H.T.; Wilhelm, J.P. (SRI International, Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 171p. NTIS, PC A08/MF A01.

The rail passenger systems of the US are described in terms of selected physical, operating, and economic characteristics, and relates services rendered to energy usage and costs. Rail passenger transportation exists in 4 distinct forms: intercity railroads, suburban railroads, heavy-rail transit, and light-rail transit. Each form varies in technical equipment, design of facilities, operating practices, size of systems. Specific data for the national rail passenger network and the Boston, Chicago, Cleveland, New York, Philadelphia, Pittsburgh, and San Francisco regions and the Washington Metropolitan area transit authority are presented.

26060 (SAN—1176-T2(Vol.3)) **Energy studies of rail passenger transportation. Volume 3. Institutions.** Henderson, C. (SRI International, Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 28p. NTIS, PC A03/MF A01.

The institutional structures of most rail passenger systems have undergone major changes during the past decade because of the decline in private ownership and control and the increase in responsibilities of numerous public agencies - both long established and newly created. These shifts in ownership and control are described and some of the institution-related problems that Federal agencies may encounter in planning and executing future programs for energy conservation in rail passenger transportation are discussed. The principal private companies and public agencies participating in rail passenger transportation are briefly discussed.

26061 (SAN—1176-T2(Vol.4)) **Energy study of rail passenger transportation. Volume 4. Efficiency improvements and industry future. Final report.** Henderson, C.; Wilhelm, J.P. (SRI International, Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 63p. NTIS, PC A04/MF A01.

Measures that offer promise of efficiency improvements or economy in energy usage in rail passenger transportation are identified and described; the future of rail passenger transportation in the US is discussed; and possible future roles of Federal agencies are discussed.

26062 (SAN—1176-T4) **Railroad electrification in America's future: an assessment of prospects and impacts. Final report.** White, R.K.; Yabroff, I.W.; Dickson, E.M.; Zink, R.A.; Gray, M.E.; Moon, A.E. (SRI International, Menlo Park, CA (USA)). Jan 1980. Contract EY-76-C-03-1176. 175p. NTIS, PC A08/MF A01.

Such considerations as the level of traffic, the relative financial health of individual railroads, the capacity of the associated supply and engineering/construction industries, and the logical connecting points at classifying yards, as well as the national interest value of creating a continuous system, continental in scope, were used to construct a scenario for railroad electrification that closely approximates how an electrification program might be implemented. For the economic reasons cited, much of the US railroad system would remain conventionally powered. This scenario provides for an electrified network involving 14 mainlines operated by 10 compa-

nies that could transport much of the nation's rail-borne freight. Five years of planning and engineering work would be required for each link before construction could begin. With 1000 miles or less of electrified route per year, 14 years would be needed to construct the 9000-mile network of our scenario. (The scenario constructed runs from 1980 to 1998.) The analysis was aided with the construction of the SRI Railroad Industry Model. Basically a model of industry operations and finances, the model produces income statements and balance sheets at yearly intervals. Railroad energy costs, railroad freight levels, maintenance costs, purchases and leases of rooling stock, electrification facility investments, future inflation, rate setting practices, annual depreciation, taxes, and profits were calculated.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 26057

26063 (NP—24333) **Working Group on Fuel Consumption Targets. Interim report.** (Department of Energy, London (UK)). 27 Jun 1979. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The UK Working Group on Fuel Consumption Targets was created in 1978 to investigate the feasibility of setting progressive targets for raising the average mpg achieved by new cars and methods of achieving these targets and to report to the Automotive Energy Consultative Group. The standards established for cars and the factors that influence the standards are discussed. Proposals for a voluntary fuel consumption targets scheme were submitted to the Working Group by representatives of the Society of Motor Manufacturers and Traders. The text of that scheme is given in annexes to the report. (MCW)

26064 **Automotive industry.** MacDonald, N.B. pp 79-89 of Opportunities in Canadian transportation. Ottawa, Canada; Science Council of Canada (1980).

From Auto as a mode/industry sub-conference; Toronto, Canada (4 Oct 1979).

The structure of the North American passenger vehicle industry is compared to that in Europe and Japan. In contrast to the European and Japanese automotive industries, which are innovative and adaptive to change, the North American industry is characterized by an orderly consdervatism in which internalized product design and parts manufacturing processes change very slowly. It is suggested that recent demand for change in the industry had probably accelerated faster than the parent industry's ability to change. Thus, US vehicle manufacturers appeared to be prepared to undertake more out-of-house parts sourcing, thus presenting major industrial opportunities for Canada. This pattern is viewed not only as an opportunity to attract more industry to Canada, but also as a means of initiating product development mandates for the vehicle manufacturers, which are now absent, and expanding product development by the independent parts producer. For these opportunities to be realized, these obstacles must be overcome: restrictive labor laws, higher parts production costs in Canada than in the US, and an absence of low-cost loans and tax incentives for industry. Another opportunity for Canadian part producers is the Designated Vehicle Importer orders now given to non-North American vehicle manufacturers on the basis of their buying certain values of parts in Canada for vehicles designated for Canada. It would be desirable for offshore vehicle importers to have a commitment to Canada in the form of capital investment. It is concluded that this would reduce investment risks to the parts industry.

SEA AND WATER

REFER ALSO TO CITATION(S) 26082

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 25676

26065 (DOE/TIC—11118) **Pilot study to select candidates for energy. Conservation research for the chemical industry. Final report.** Burch, J.E.; Otis, J.L.; Hale, R.W. (Battelle Columbus Labs., OH (USA)). 15 Nov 1979. Contract W-7405-ENG-92-113. 116p. NTIS, PC A06/MF A01.

Every chemical process consists of one or more unit operations that effect physical changes in the raw materials, intermediates, or products. Many of these unit operations are used, singly or in combination, with unit processes to effect chemical changes. The same or different combinations of unit operations may be used to effect similar chemical changes in different chemical processes. This project was designed to study the functions and energy consumption of the various unit operations involved in several chemical processes and to identify areas where research could lead to energy-conservation options of broad utility to the chemical industry. Four energy-intensive chemical processes which produce ammonia and carbon dioxide, chlorine and caustic soda, carbon black, and ethylbenzene and styrene were selected for this study. Information was obtained from the literature on the structure of the industry sectors and the production technologies, and was used to determine material balances, process streams, temperatures, pressures, and energy requirements for the various unit operations. An energy matrix was prepared for each process, showing the function provided by and the energy involved in each unit operation or process. A variety of chemical engineers and chemists analyzed the energy matrices, flow charts, and other information for each process and made suggestions as to areas wherein research might be expected to produce energy-saving results.

ENERGY SOURCES

REFER ALSO TO CITATION(S) 25305, 25423

26066 (CONF-800721—1) **Irrigation and the demand for electricity. Progress report.** Maddigan, R.J.; Chern, W.S.; Gallagher, C.A. (Oak Ridge National Lab., TN (USA)). Mar 1980. Contract W-7405-ENG-26. 21p. NTIS, PC A02/MF A01.

From Annual meeting of the American Agricultural Economic Association; Urbana, IL, USA (27 Jul 1980).

In order to anticipate the need for generating capacity, utility planners must estimate the future growth in electricity demand. The need for demand forecasts is no less important for the nation's Rural Electric Cooperatives (RECs) than it is for the investor-owned utilities. The RECs serve an historically agrarian region; therefore, the irrigation sector accounts for a significant portion of the western RECs' total demand. A model is developed of the RECs' demand for electricity used in irrigation. The model is a simultaneous equation system which focuses on both the short-run utilization of electricity in irrigation and the long-run determination of the number of irrigators using electricity. Irrigation demand is described by a set of equations in which the quantity of electricity demanded, the average electricity price, the number of irrigation customers, and the ratio of electricity to total energy used for irrigation are endogenous. The structural equations are estimated using pooled state-level data for the period 1961-1977. In light of the model's results, the impact of changes in relative energy prices on irrigation can be examined.

26067 (FE—3157-T1) **Development of pulverized coal-fired glass furnace. Final report.** Morton, J.W.; Bianco, J.H.; Jones, H.R.; Saha, A.K.; Sheehan, D. (Burns and Roe Industrial Services Corp., Paramus, NJ (USA); TUSCO Engineering Co., Inc., Commerce City, CO (USA)). May 1979. Contract ET-78-C-01-3157. 177p. NTIS, PC A09/MF A01.

The substitution of pulverized coal for the fuel oil and natural gas burned in existing glass furnaces in the US glass container industry in 1979 could save \$100 x 10^6 in fuel bills. The main problem with coal substitution in these furnaces is to determine the effects of coal-firing on furnace and regenerator life. Research on the economic and technical feasibility of such coal substitution is reported. It is concluded that conversion of the glass furnaces to pulverized-coal firing is economically attractive and long-term tests with this firing should be undertaken. (LCL)

EQUIPMENT AND PROCESSES

26068 (COO—2918-T1) **Microwave-vacuum drying system: (MIVAC). Progress report No. 5, final.** Wear, F.C. (McDonnell Douglas Corp., St. Louis, MO (USA)). 30 Jun 1979. Contract EY-76-C-02-2918. 54p. NTIS, PC A04/MF A01.

The design and public demonstration of the MIVAC Drying System for drying peanuts, corn, sorghum, corn, and rice and the drying times with various dryer systems are reported. (LCL)

26069 (DOE/NASA/0030—80/2) **Cogeneration technology alternatives study (CTAS). Volume II. Industrial process characteristics. Final report.** (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Jan 1980. Contract EC-77-A-31-1062. 698p. (NASA-CR—159760(Vol.2)). Dep. NTIS, PC A99/MF A01.

The Cogeneration Technology Alternatives Study (CTAS) provides data and information in the area of advanced energy conversion systems for industrial cogeneration applications in the 1985 to 2000 time period. Six current and thirty-six advanced energy conversion systems were defined and combined with appropriate balance-of-plant equipment. Twenty-six industrial processes were selected from among the high energy consuming industries to serve as a framework for the study. Each conversion system was analyzed as a cogenerator with each industrial plant. Fuel consumption, costs, and environmental intrusion were evaluated and compared to corresponding traditional values. Various cogeneration strategies were analyzed and both topping and bottoming (using industrial by-product heat) applications were included. The advanced energy conversion technologies indicated reduced fuel consumption, costs, and emissions. Typically fuel energy savings of 10 to 25% were predicted compared to traditional on-site furnaces and utility elec-

tricity. With the variety of industrial requirements, each advanced technology had attractive applications. Overall, fuel cells indicated the greatest fuel energy savings and emission reductions. Gas turbines and combined cycles indicated high overall annual cost savings. Steam turbines and gas turbines produced high estimated returns. In some applications, diesels were most efficient. The advanced technologies used coal-derived fuels, or coal with advanced fluid bed combustion or on-site gasification systems. This volume presents industrial processes data and information developed by Gordian Associates, Incorporated used in the study.

26070 (ORAU/IEA—80-4(M)) **Assessment of industrial energy conservation by unit processes.** Phung, D.L.; van Gool, W.; Boyd, D.A.; Casavant, D.; Devine, W.D. Jr.; Plaza, H.; Pollard, W.G. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). Mar 1980. Contract AC05-76OR00033. 191p. NTIS, PC A09/MF A01.

Recent rises in energy prices, increasing dependence on imported fuels, and realization of the inherent nonrenewability of fossil resources have created a government role in energy production and conservation. It may be presumed that government conservation policy should include encouraging industry to conserve more than current prices would demand, in anticipation of long-term total costs to the nation of energy use. But such a policy requires investment. How much investment will be required to produce a given amount of conservation? How much conservation can be accomplished before its costs equal those of new supply? How should a given investment be allocated to yield the largest energy savings? These questions are addressed from the perspective of energy use in industrial unit operations. It was found that: a real energy minimum exists which is distinct from the process thermodynamic limit, and this minimum represents the limit to conservation; cost/energy relationships for an industrial process can be described to first approximation by a single technology parameter, which is characteristic of that particular technology; the technology parameter permits competing technologies to be ranked by energy-saving potential for a given investment; and government investment in conservation can be allocated for greatest return using the technology parameters of, and the fractions of energy use by, each of the unit operations. Energy embodied in conservation equipment may, under certain circumstances, decrease the rate at which the benefits of conservation appear in national energy accounts.

26071 **Compound heat pump gas turbine: an approach to energy conservation for process industries.** Fejer, A.A. Chicago, IL; Institute of Gas Technology (1980). 8p. (CONF-800302—6).

From 25. international gas turbine conference; New Orleans, LA, USA (9 Mar 1980).

A compound heat pump gas turbine engine is proposed to achieve energy conservation in industrial processes that require cooling or refrigeration as well as electric power and process heat. This novel machine is basically the combination of a reversed cycle Brayton engine driven by a gas tubine, with the two engines having a common compressor. Because of this arrangement, the machine is very compact and should be relatively inexpensive to produce. Also, it can be adapted to a variety of fuels. The thermodynamic cycle and some performance characteristics of the compound engine are presented and the potential of such a machine for a meat packing plant is demonstrated. It was concluded from this study that this engine layout will result in significant reductions in engine cost, compared with systems consisting of separate components for power generation, refrigeration, and process heating. In addition, significant savings in energy consumption may be realized. Furthermore, it appears that engines of this type can be made to meet widely differing specifications as far as the split between process heat refrigeration and shaftpower is concerned. Finally, the engine can be made up of compressors, turbine stages, and heat exchangers of relatively simple design without penalties in economy, because the energy savings are achieved in this type of engine by reduction or complete elimination of waste heat, rather than high efficiencies of engine components. The possible energy savings for the meat packing industry indicate that the compound heat pump gas turbine deserves further study, including its cost, operating expenses, and environmental aspects. (LCL)

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 25216, 25872, 25918, 25919, 25920, 26069, 26071

26072 (CONF-791232—, pp 85-94) **Industrial storage applications overview.** Duscha, R.A. (NASA, Cleveland, OH). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The major tasks in this program element are the implementation of a thermal energy storage technology demonstration for the food processing industry, development and technology demonstrations for selected near-term, in-plant applications and advanced industrial applications. These tasks will be supported by an on-going system studies activity which will assess advanced applications, solar industrial applications, and heat transport requirements. An important adjunct to this activity is the continued implementation of technology transfer through information collection and dissemination.

26073 (CONF-791232—, pp 95-104) **Applications of thermal energy storage to waste heat recovery in the food processing industry.** Wojnar, F.; Lundberg, W.L. (Westinghouse Electric Corp., Pittsburgh, PA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The canning segment of the food processing industry is a major energy user within that industry. Most of its energy demand is met by hot water and steam and those fluids, in addition to product cooling water, eventually flow from the processes as warm waste water. To minimize the possibility of product contamination, a large percentage of that waste water is sent directly to factory drains and sewer systems without being recycled. And in many cases, the thermal energy contained by the waste streams also goes unreclaimed and is lost from further use. A study discussed herein indicates that the recovery of waste heat in canning facilities can be performed in significant quantities using systems involving thermal energy storage (TES) that are both practical and economical. A demonstration project has been proposed to determine actual waste heat recovery costs and benefits and to encourage system implementation by the food industry.

26074 (SAN—1692-T1) **Industrial recovered-materials-utilization targets for the metals and metal-products industry.** (Little (Arthur D.), Inc., Cambridge, MA (USA)). Mar 1980. Contract EM-78-C-03-1692. 314p. Dep. NTIS, PC A14/MF A01.

The National Energy Conservation Policy Act of 1978 directs DOE to set targets for increased utilization of energy-saving recovered materials for certain industries. These targets are to be established at levels representing the maximum feasible increase in utilization of recovered materials that can be achieved progressively by January 1, 1987 and is consistent with technical and economic factors. A benefit to be derived from the increased use of recoverable materials is in energy savings, as state in the Act. Therefore, emhasis on different industries in the metals sector has been related to their energy consumption. The ferrous industry (iron and steel, ferrour foundries and ferralloys), as defined here, accounts for approximately 3%, and all others for the remaining 3%. Energy consumed in the lead and zinc segments is less than 1% each. Emphasis is placed on the ferrous scrap users, followed by the aluminum and copper industries. A bibliography with 209 citations is included.

26075 (SAN—1694-T1) **Industrial recovered-materials-utilization targets for the textile-mill-products industry.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). 1979. Contract EM-78-C-03-1694. 292p. Dep. NTIS, PC A13/MF A01.

The Congress, in the National Energy Conservation and Policy Act of 1978 (NECPA), directed the Department of Energy to establish materials recovery targets for the metals and metal products, paper and allied products, rubber, and textile-mill-products industries. The targets were developed to provide incentives for using energy-saving recorded materials and to provied a yardstick for measuring progress and improvement in this endeavor. The NECPA indicates that the targets should represent the maximum technically and economically feasible increase in the use of energy-saving recovered materials that each industry can achieve progressively by January 1, 1987. Materials affected by recovered-materials targets include and are limited to aluminum, copper, lead, zinc, iron, steel, paper and associated products, textile-mill, products, and rubber. Using information gathered from the textile-mill-products industry and from other textile-relaed sources, DOE has developed recovered materials targets for that industry. This report presents those targets and their basis and justification. Following an overview of the textile industry, the chapters are: Textile-Mill-Products Industry Operations; Economic Analysis of the Textile-Mill-Products Industry; Governmental and Regulatory Influence on the US Textile Industry; Current Mill Use of Recovered Materials in the Textile-Mill-Products Industry; Limitations on the Use of Recovered Materials in the US Textile-Mill-Products Industry; Materials-Recovery Targets; and Government and Industry Actions That Could Increase the Use of Recovered Materials.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 25218, 25220, 25293, 25460, 25461, 25586, 26074, 26075, 26336

26076 (DOE/ET/10415—39) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly technical progress report, December 1979-February 1980.** Minnick, L.J.

(Minnick (L.J.), Inc., Plymouth Meeting, PA (USA)). 1980. Contract AC21-77-ET10415. 35p. NTIS, PC A03/MF A01.

The free lime content of the spent bed residue sample from the Georgetown AFB boiler has higher than average free lime, total lime, and magnesium content, and smaller than normal proportion of silica, aluminum, and iron, when compared to previously analyzed spent bed residue samples from other sources. Investigation of the use of spent bed residue as a component of blended cement revealed expansive properties which make such use for conventional concrete construction purposes somewhat questionable. However, these blended cement mixes expand in a predictable manner, show no cracking, and do increase in strength over time, suggesting their application as an expansive concrete for pressure gouting and stowage for mine backfilling. AFB residue/fly ash blends mixed with clay-silt soil exhibit strength development and volume stability characteristics that further recommend the application of such blends as a soil grouting medium. The information and experience obtained in the masonry block demonstration permit an accurate design of mix formulations using AFB residue with conventional block making equipment to meet current ASTM specifications for masonry block. Pre-treatment is necessary in order to develop high-carbon AFB fly ash for use in water treatment applications.

26077 (SAN—1704-T1) **Industrial recovered materials utilization targets for the paper and allied products industry.** (Resource Planning Associates, Inc., Cambridge, MA (USA)). [nd]. Contract EC-77-C-03-1704. 177p. NTIS, PC A09/MF A01.

An analysis is presented in support of the targets for industrial recovered-materials utilization in the paper and allied products industry. The industry and recovered materials, respectively, are defined. The methodology for setting the 1987 targets for use of recovered materials is outlined. The technically feasible and economically practical use of recovered materials in manufacturing each of 10 grades of paper and paperboard is projected. These projections in view of projected supplies of recovered materials and the effects of government actions on projected supply and use of recovered materials are evaluated. The targets for use of recovered materials in each of the 10 paper and paperboard grades and in the industry as a whole are set. Finally, the effect of recovered-materials use on energy consumption in paper and paperboard manufacturing under four scenarios is examined and the principal issues that a subsequent analysis would need to resolve are identified.

MUNICIPALITIES AND COMMUNITY SYSTEMS

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 25280, 25991

26078 (CONF-791232—, pp 283-295) **Evaluation of thermal energy storage for the proposed twin cities district heat system.** Meyer, C.F. (General Electric Co., Santa Barbara, CA). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

TEMPO studies beginning in 1972 have shown that thermal energy storage (TES) in aquifers could greatly improve the opportunities for conserving substantial amounts of energy (with concomitant reduction in environmental pollution) through large-scale cogeneration. If large-scale annual-cycle TES were available, it could solve the mismatch problem which limits the amount of cogenerated heat for which a market can be found. The mismatch problem arises because electricity must be generated in instantaneous response to demand (no feasible way to store electricity is available); and demands for heat seldom correspond to electric generation in time, location, or magnitude. The largest potential market for cogenerated heat is space heating - an annual-cycle load - served by district heat. Comparing the capital requirements and fuel consumption of a specific cogeneration/district heating system which does not include TES to those of a system with TES, serving identical loads, provides a measure of the value of the TES. The potential benefits of incorporating aquifer TES into the proposed Twin Cities cogeneration-district heating system include: saving the cost of installing boilers; avoiding problems of siting boilers at each transmission node; avoiding air-pollution problems of dispersed boilers; replacing oil burned in boilers with coal burned at central cogeneration plants; reducing net energy consumption and cost; operating cogeneration equipment at higher capacity factor, to reduce cost of both electricity and heat; permitting more economic cogeneration, with backpressure turbines instead of extraction turbines; reducing the amount of cogeneration capacity required; reducing thermal pollution from power plants; reducing the need for cooling water or towers; and reducing size, cost, and heat losses of transmission pipelines. Annual-cycle aquifer storage appears capable of providing these benefits.

26079 (COO—4976-1(Vol.1)) **District heating and cooling systems for communities through power plant retrofit and distribution network, City of Piqua, Ohio.** (City of Piqua, OH (USA); Georgia Inst. of Tech., Atlanta (USA); Hanselman-Eskew and Associates, Piqua, OH (USA)). 18 Sep 1979. Contract EM-78-C-02-4976. 60p. NTIS, PC A04/MF A01.

The goal of the Piqua, Ohio District Heating and Cooling Demonstration Project is to demonstrate the feasibility and efficiency of using cogenerated thermal energy from the City's Municipal Power Plant to provide residential, commercial and industrial space heating and cooling and satisfy other community energy needs as appropriate. Progress in four tasks within this project is reported. These tasks include: development of team work plan resource allocation; identification of thermal energy source market; analysis of energy market; and planning of power plant retrofits. (LCL)

26080 (COO—4981-1(Vol.2)) **District heating and cooling systems for communities through power plant retrofit and distribution networks. Phase 1: identificatzon and assessment. Final report, Volume II. Detailed results.** (Wisconsin State Energy Office, Madison (USA)). Sep 1979. Contract EM-78-C-02-4981. 192p. NTIS, PC A09/MF A01.

The Phase I Identification and Assessment Study was aimed at surveying the State of Wisconsin to identify potential sites for a district heating system and evaluating these sites in terms of their technical, institutional and economic merits. Specific objectives of the study were to: identify candidate plants and service areas and to perform an energy market analysis for selected areas; identify and evaluate plant retrofit and distribution alternatives for the selected service areas; identify and evaluate institutional problems within the infrastructure; and perform an economic analysis for the candidate sites. The overall approach consisted of surveying the State of Wisconsin to identify all existing intermediate and base-loaded electric generating facilities. Once identified, screening criteria were developed to narrow the list to the three most promising sites. For each of the three sites, an extensive market analysis was performed to identify and characterize thermal loads and survey potential users on their views and concerns on the concept. Parallel to this effort, each of the three sites was evaluated on its technical and institutional merits. The technical evaluation centered on identifying and evaluating utility plant retrofit schemes and distribution system alternatives to service the identified thermal market. The institutional analysis evaluated potential barriers such as environmental, distribution system right-of-way and legal issues within the infrastructure of the state, city and community. Finally, all previous aspects of the analysis were combined to determine the economic viability of each site. The most promising site is Green Bay where process heat loads as well as building heat loads are located near the Pulliam Power Plant.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26336

26081 (COO—4980-1(App)) **Minnesota Project: district heating and cooling through power plant retrofit and distribution network. Final report. Phase 1.** (Minnesota Energy Agency, St. Paul (USA)). [nd]. Contract EM-78-C-02-4980. 146p. NTIS, PC A07/MF A01.

Appendices are presented for the Minnesota Project: District Heating and Cooling Through Power Plant Retrofit and Distribution Network. These are: SYNTHA results (SYNTHA II is a proprietary program of the SYNTHA Corporation); Market Survey Questionnaire: Environmental Review Procedures; Public Service Commission Regulation of District Heating; Energy Use Normalization Procedures; Power Plant Description; Letters of Commitment; Bond Opinion and Issuance; and Marvin Koeplin Letter, Chairman of Public Service Commission, Moorehead, Minnesota.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 26085

DIESEL

26082 **Sulzer two-stroke developments.** *Diesel Eng. Gas Turbines;* **76**: No. 802, 146-150, 139(Aut 1979).

The new RLA90 design of a slow-running two-stroke diesel engine is directed toward greater reliability, together with an ability to burn even poorer quality fuel oils and coal-derived liquid fuels. The RLA90 extends the successful RN-M engine series for marine propulsion installations requiring either lower engine speeds, lower unit outputs, or higher unit outputs. The improvement in fuel con-

sumption, its ability to burn low-quality fuels, and especially to burn coal-derived fuel SRC II are described.

ELECTRIC-POWERED SYSTEMS

26083 (DOE/NASA/0081—79/1) **Advanced electric propulsion system concept for electric vehicles.** Raynard, A.E.; Forbes, F.E. (AiResearch Mfg. Co., Torrance, CA (USA)). Aug 1979. Contract EC-77-A-31-1044. 161p. (NASA-CR—159651; AIRESEARCH—79-16182). NTIS, PC A08/MF A01.

The objective of this study was to evaluate 17 propulsion system concepts for electric vehicles, and to make conceptual designs of the two most promising configurations. The preliminary analysis compared all systems on a common basis of performance to determine the differences in components and battery pack to achieve the basic performance level. Design tradeoffs were made for selected configurations to find the optimum component characteristics required to meet all performance goals. Comparisons were made not only of range, but also of acceleration and cost. An evaluation was also made of the anticipated performance when using nickel-zinc batteries rather than the standard lead-acid batteries. The two systems selected for the final conceptual design studies included a system with a flywheel energy storage unit and a basic system that did not have a flywheel. Both systems meet the range requirements of 161 km with the SAE J227a schedule D cycle and 209 km at a constant 89 km/hr. The flywheel system meets the range requirement with either lead-acid or nickel-zinc batteries and also the acceleration of zero to 89 km/hr in 15 s. The basic system can also meet the required performance with a fully charged battery, but, when the battery approaches 20 to 30 percent depth of discharge, maximum acceleration capability gradually degrades, although the other performance goals can be met. The flywheelsystem has an estimated life-cycle cost of $0.041/km using lead-acid batteries. The basic system, due to the more strenuous demands on the battery, has a life-cycle cost of $0.06/km. The basic system, using batteries meeting ISOA goals, would have a life-cycle cost of $0.043/km.

26084 (EPRI-EM—1326) **Electric vehicles: how do they compare with synthetic liquid fuels. Final report.** Goodson, R.E. (Purdue Univ., Lafayette, IN (USA). Automotive Transportation Center). Feb 1980. 31p. NTIS, PC A03/MF A01.

A structure for comparing various petroleum substitution options is presented and used to compare electricity for electric vehicles to synthetic liquid fuels from oil shale and coal for conventional vehicles. The results show that the EV option compares favorably to the synthetic fuel options and EV development should be pursued and evaluated along with other alternative fuels.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 26158

EMISSION CONTROL

NITROGEN OXIDES

26085 (EPA—600/7-79-050c) **Proceedings of the third stationary source combustion symposium. Volume III. Stationary engine and industrial process combustion systems.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Feb 1979. 181p. (CONF-790338—(Vol.3)). NTIS.

From 3. EPA stationary source combustion symposium; San Francisco, CA, USA (5 Mar 1979).

The proceedings document the approximately 50 presentations made during the symposium, March 5-8, 1979, in San Francisco. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory-RTP, the symposium dealt with subjects relating both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources and to improving equipment efficiency. The symposium was in seven parts, and the proceedings are in five volumes: I. Utility, Industrial, Commercial, and Residential Systems; II. Advanced Processes and Special Topics; III. Stationary Engine and Industrial Process Combustion Systems; IV. Fundamental Combustion Research and Environmental Assessment; and V. Addendum. The symposium provided contractor, industrial, and government representatives with the latest information on EPA inhouse and contract combustion research projects relating to pollution control, with emphasis on reducing NOx while controlling other emissions and improving efficiency.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 26084

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 25119, 25120, 25121, 25122, 25152

26086 (EPRI-AP—1338) **Design properties of steels for coal conversion vessels. Mechanical properties of materials.** McCabe, D.E.; Landes, J.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Jan 1980. 77p. NTIS, PC A05/MF A01.

The purpose of this report is to present a complete data log on the mechanical properties of the materials used in the present investigation. Weldments of SA387, SA542, and a type 347 stainless steel overlay were made by Chicago Bridge and Iron using base plates of typical commercial thickness and commercial welding practices. The results of preliminary mechanical property tests and microstructural examinations indicated that the material properties were sufficiently uniform and representative of conditions typical for production material properties to proceed with detailed testing. In SA387 and SA542, the microstructures were dominantly bainitic, with the average yield strengths respectively 345 MPa (50 ksi) and 496 MPa (72 ksi), due mostly to the selected tempering temperature. Average upper shelf Charpy toughness was 180 Joules (133 ft-lbs) in both SA387 and SA542 base metals but 50% FATT transition temperatures were 294°K (70°F) and 244°K (-20°F), respectively. A temper embrittling treatment was tried which raised the 50% FATT of SA387 base metal and weld metal 67°K (120°F). Upper shelf fracture energy of the SA387 base metal was reduced 50 percent by the T.E. treatment. Baseline data for the fracture mechanics type tests were developed in the form of da/dN versus ΔK/sub I/, and fracture toughness in terms of J/sub Ic/. Fatigue crack growth rate of SA387 was increased by a factor of 2 when comparing room temperature versus 727°K (850°F). Growth rate of SA542 was the same at 588°K (600°F) and room temperature. Fracture toughness by J/sub Ic/ showed the expected loss in upper shelf toughness with increased test temperature for SA387 base metal.

26087 **Applications of metallurgical coatings.** Bunshah, R.F.; Mattox, D.M. (University of California, Los Angeles, California). *Phys. Today;* **33**: No. 5, 50-55(May 1980).

The surface of a coated material can possess structure and properties quite different from those of the bulk material, thus allowing components to be individually tailored for specialized needs.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 25791, 26036, 26267

26088 **Process for stabilizing dimensions of duplex stainless steels for service at elevated temperatures.** US Patent Application 055,210. [nd]. 11p.

Duplex stainless steel materials containing austenite plus delta ferrite, are dimensionally stabilized by heating the material to a reaction temperature between about 1050 to 1450°F (566 to 788°C), holding it at this temperature during transformation of delta ferrite to austenite plus sigma phase, and subsequently heating to a reversion temperature between about 1625 to 1750°F (885 to 954°C), whereby the sigma phase transforms back to ferrite, but the austenite remains dispersed in the ferrite phase. Final controlled cooling permits transformation of ferrite to austenite plus sigma and, later, precipitation of carbides.

26089 **Low Mn alloy steel for cryogenic service.** Morris, J.W. Jr.; Niikura, M. US Patent Application 066,106. [nd]. 11p.

A ferritic cryogenic steel which has a relatively low (about 4 to 6%) manganese content and which has been made suitable for use at cryogenic temperatures by a thermal cycling treatment followed by a final tempering. The steel includes 4 to 6% manganese, 0.02 to 0.06% carbon, 0.1 to 0.4% molybdenum and 0 to 3% nickel.

26090 (CONS—5089-8) **Production of aluminum-silicon alloy and ferrosilicon and commercial purity aluminum by the direct reduction process. Fourth interim technical report, Phase B, June 1-August 31, 1979.** Bruno, M.J. (Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.). Sep 1979. Contract EC-77-C-01-5089. 22p. NTIS, PC A02/MF A01.

A series of calculated energy balances were made on alternate thermal processes for Al and Al-Si production. The computer modeling program was checked for validity by modeling low shaft Si production and comparing to known commercial conditions. Burden materials ground to -65 mesh prior to agglomeration compared favorably to -200 mesh grinds. Ball forming agglomeration was developed for bauxite-clay-coke mixes. The balls produced had higher strength and abrasion resistance than extrusions made from the same formulations. It was determined that Neutron Activation Analysis for Al, Si, Fe and oxygen combined with the analysis of Ti by atomic absorption and carbon by combustion provided the best analytical procedure for reactor metal samples. A series of induction heated runs were made. Continuous, steady-state operation produced significant quantities of coalesced metal alloy; individual metal yields for Al, Si, Fe and Ti ranged from 64 to 93%. The mechanical Auger was successfully operated to minimize burden bridging during the induction heated runs. Revisions were made to burden support grate-liner assembly, the tuyere to shell seals and the Auger design, improving reliability of reactor operation. Extensive phase analyses were completed on metal product samples by optical microscope techniques, resulting in identification of phases and understanding of relationships between phases formed.

26091 (ORNL/TM—7258) **High-power laser and arc welding of thorium-doped iridium alloys.** David, S.A.; Liu, C.T. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 38p. NTIS, PC A03/MF A01.

The arc and laser weldabilities of two Ir-0.3% W alloys containing 60 and 200 wt ppM Th have been investigated. The Ir-.03% W alloy containing 200 wt ppM Th is severely prone to hot cracking during gas tungsten-arc welding. Weld metal cracking results from the combined effects of heat-affected zone liquation cracking and solidification cracking. Scanning electron microscopic analysis of the fractured surface revealed patches of low-melting eutectic. The cracking is influenced to a great extent by the fusion zone microstructure and thorium content. The alloy has been welded with a continuous-wave high-power CO_2 laser system with beam power ranging from 5 to 10 kW and welding speeds of 8 to 25 mm/s. Successful laser welds without hot cracking have been obtained in this particular alloy. This is attributable to the highly concentrated heat source available in the laser beam and the refinement in fusion zone microstructure obtained during laser welding. Efforts to refine the fusion zone structure during gas tungsten-arc welding of Ir-0.3 % W alloy containing 60 wt ppM Th were partially successful. Here transverse arc oscillation during gas tungsten-arc welding refines the fusion zone structure to a certain extent. However, microstructural analysis of this alloy's laser welds indicates further refinement in the fusion zone microstructure than in that from the gas tungsten-arc process using arc oscillations. The fusion zone structure of the laser weld is a strong function of welding speed.

26092 (UCID—18517) **Mechanical properties of copper electrodeposited from a commercial pyrophosphate solution.** Wiesner, H.J.; Cowden, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jan 1980. Contract W-7405-ENG-48. 13p. NTIS, PC A02/MF A01.

Commercial copper pyrophosphate electroplating solutions containing different concentrations of organic addition agents were studied to determine if copper electrodeposits with consistent mechanical properties could be obtained. Cyclic voltammetry was used to monitor and control the concentration of the addition agents, and thus to maintain the brightness of the deposits and to obtain the desired mechanical properties. The present experiments provided mechanical-property data showing that when a single organic addition agent is used, the copper deposits can achieve ultimate strengths of 300 to 330 MPa and elongations of 25 to 27%. With a second agent present, the ultimate strength is raised to 710 to 775 MPa and the elongation drops to 6.8 to 8.4%.

26093 **Method for making defect-free zone by laser-annealing of doped silicon.** Narayan, J.; White, C.W.; Young, R.T. (to Dept. of Energy). US Patent 4,181,538. 1 Jan 1980. Filed date 26 Sep 1978. 14p.

PAT-APPL-945,925.

A method for improving the electrical properties of silicon semiconductor material is given. The method comprises irradiating a selected surface layer of the semiconductor material with high-power laser pulses characterized by a special combination of wavelength, energy level, and duration. The combination effects melting of the layer without degrading electrical properties, such as minority-carrier diffusion length. The method is applicable to improving the electrical properties of n- and p-type silicon which is to be doped to form an electrical junction therein. Another important application of the method is the virtually complete removal of doping-induced defects from ion-implanted or diffusion-doped silicon substrates.

26094 **Manufacture of thin self-supporting ^{238}U foils.** Ellsworth, C.E.; Shotter, A.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Instrum. Methods;* **165**: No. 2, 349(1 Oct 1979).

A method is described for the manufacture of self-supporting ^{238}U foils of thickness within the range 400-1400 $\mu g\ cm^{-2}$. The basic principle of manufacture involves electron bombardment within a vacuum chamber of a 300-400 mg. chip of metallic ^{238}U contained in a tungsten crucible.

26095 **Polishing single-point diamond-turned metal reflective optics.** Baker, P.C.; Brown, N.J. (Univ. of California, Livermore). *Opt. Eng.;* **17**: No. 6, 595-601(Nov 1978).

A procedure is described for the use of diamond-impregnated pitch and silicone oil which has produced surfaces which appear to be as smooth as 5 Angstrom rms on small flat samples removing the objectionable diffraction-producing grooves that sometimes accompany diamond turning. Possible mechanisms are described together with the procedures and equipment used to polish an x-ray microscope and a uv telescope.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 26090, 26091, 26099, 26145

26096 (DOE/ER/05002—7) **Grain boundary dislocations in plane matching grain boundaries.** Schindler, R.; Clemans, J.E.; Balluffi, R.W. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). Aug 1979. Contract AS02-78ER05002. 34p. NTIS, PC A03/MF A01.

Plane matching (PM) boundaries are defined as boundaries in which a single stack of planes of indices (hkl) in each crystal adjoining the boundary is either parallel, or nearly parallel, and where no other significant lattice matching exists. A search was made (by transmission electron microscopy) for possible intrinsic secondary grain boundary dislocation (GBD) arrays which might be present in such boundaries possessing a variety of deviations from the exact PM condition. (002), (220) and (420) PM boundaries of controlled geometry were prepared in gold thin film bicrystal specimens. Wide ranges of twist and tilt deviations from the exact PM orientation were introduced, and the orientation of the boundary plane was also varied for cases of fixed crystal misorientation. Arrays consisting of parallel GBDs were found in the (002) and (220) boundaries but not in the (420) boundaries. The Burgers vector of the GBDs was parallel to [hkl] with a magnitude given by the (hkl) interplanar spacing. Arrays were found in boundaries with twist deviations as large as 4° and tilt deviations as large as 14° and with a wide range of grain boundary plane orientations. The results suggest that discrete GBDs should be present in a variety of (002), (111) and (220) PM boundaries over a considerable range of misorientation which in certain cases may be as large as 20°. Such boundaries should therefore appear rather frequently in general polycrystalline materials in agreement with the estimates of Warrington and Boon. It is pointed out that the physical basis for the stability of such GBD structures is not understood at present.

26097 (RFP—2885) **Precipitation reactions in a beryllium-bearing stainless steel.** Carr, M.J.; Heiple, C.R. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-DP03533. 4p. (CONF-800801—2). NTIS, PC A02/MF A01.

From 39. annual meeting of the Electron Microscopy Society of America and the 15. annual meeting of the Microbeam Analysis Society; San Francisco, CA, USA (4 Aug 1980).

Precipitation reactions in a beryllium-bearing stainless steel alloy have been studied by TEM and electron diffraction for ageing temperatures between 400° and 900°C. The nominal composition of the alloy was 38% Ni - 21% Cr - 1% Mn - 0.5% Be - Bal Fe. Specimens were solutionized for one hour at 1150°C and water quenched. The ageing reaction was studied by hardness measurements for times between 0.5 and 16 hours. The TEM specimens dicussed herein were made from samples aged one hour.

26098 **^{57}Moessbauer study of Th_7Fe_3 and the hydride $Th_7Fe_3Hsub(14.2)$.** Viccaro, P.J.; Shenoy, G.K.; Dunlap, B.D.; Westlake, D.G. (Argonne National Lab., IL (USA)); Malik, S.K.; Wallace, W.E. (Pittsburgh Univ., PA (USA)). *J. Phys. (Paris), Colloq.;* No. 2, C2.157-C2.158(1979).

From 8. International conference on applications of the Moessbauer effect; Kyoto, Japan (28 Aug - 1 Sep 1978).

Th_7Fe_3 is known to be a Pauli paramagnet and to undergo a superconducting transition at 1.86°K. In contrast, its saturated hydride $Th_7Fe_3H_{30}$ shows magnetic ordering. For the stable hydride considered here of intermediate concentration $Th_7Fe_3Hsub(14.2)$, the ^{57}Fe saturated hyperfine field to estimate to be approximately 20 kG. A positive isomer shift of 0.30+-0.02 mm/s at 300 K relative to Th_7Fe_3 would be consistent with an increase of d character at the Fe site induced by hydrogen.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 26088, 26092, 26140, 26238, 26737

26099 (DOE/ER/04072—3) **Strain hardening and ductility of iron: axisymmetric vs plane strain elongation. Technical progress report.** Langford, G. (Drexel Univ., Philadelphia, PA (USA). Dept. of Materials Engineering). May 1980. Contract AC02-76ER04072. 72p. NTIS, PC A04/MF A01.

The strain hardening of iron at high strains in plane strain elongation (strip drawing) is shown to fall increasingly below that of drawn iron wires at true strains above 2, going through zero strain hardening at $\epsilon = 3.0$, and becoming strongly negative thereafter, at least up to $\epsilon = 4.1$. High resolution selected area electron diffraction has been used to map the size, shape and crystallographic orientations of a group of about 50 contiguous cells centered around an incipient shear band in an edge section of a strip drawn to $\epsilon = 1.8$. This map shows no textural instability or change in orientation associated with the shear band, although it does show substantial misorientations throughout the group of cells, the axis of these misorientations lying in the same direction as the trace of the shear band. No other large misorientations (i.e. 5° or so) are present. The only instability seen in this shear band is microstructural: the slip distances in the two primary slip directions are quite anisotropic, being much longer along the trace of the shear band. Note that this shear band has appeared during the linear hardening portion of the high-strain hardening curve of the drawn strip. It is therefore considered a direct weakening mechanism rather than a result of another weakening effect. Further such orientation maps have been or are being prepared for more highly deformed strip, and for wire and pure-shear specimens as well.

26100 (DOE/ET/33002—T1) **Thermoelectric materials evaluation program spring design to minimize load relaxation.** (Minnesota Mining and Mfg. Co., St. Paul (USA). Industrial Electrical Products Div.). 31 Mar 1980. Contract AC02-76ET33002. 14p. NTIS, PC A02/MF A01.

The objective of the spring relaxation study was to find a spring material whose fabrication technique and operating stress level would limit the spring relaxation to an acceptable amount over a period of 50,000 hours in a thermoelectric generator environment. A total relaxation of 10% in 50,000 hours would not significantly lower the efficiency of the generator and therefore is an acceptable amount. The recommended spring material for use in thermoelectric modules is either Inconel X or Elgiloy. This recommendation is based on their excellent performance and availability. The stress level which has been shown to be very safe for generator applications is 75,000 psi.

26101 (EPRI-AP—1337) **Design properties of steels for coal conversion vessels. Rising load tests.** McCabe, D.E.; Landes, J.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Jan 1980. 52p. NTIS, PC A04/MF A01.

This report describes the results of rising load type fracture toughness tests on materials of potential interest in coal conversion vessels, such as 2-1/4-1Mo steels (grades A387 and A542) and weld overlay 347 stainless steel. The tests were conducted in a standard environment of 6%H_2S-H_2 with pressures in the range of 5.5 to 24.1 MPa (800 to 3500 psi) and temperatures in the range of 298 to 727°K (77 to 850°F). At room temperature all of the materials were found to be susceptible to subcritical crack growth resulting in values of threshold stress intensity for cracking (K/sub Iscc/) that were about 30% of the baseline K/sub Ic/ values derived from J/sub Ic/ and obtained in air. At 588°K, subcritical crack growth was no longer observed in almost all of the materials. However, a new mechanism of damage was observed selectively in some samples, such as A-387 samples prepared from the mid-thickness of the plate. Plastic deformation was found to set in at load levels much lower than in air, presumably due to hydrogen-induced plasticity. This effect became more predominant with increased temperature so that at 727°K all the test samples showed pronounced plasticity. Subsequent fracture of these samples at room temperature frequently resulted in brittle fractures, indicating that some form of permanent damage had in fact resulted due to the high temperature tests.

26102 (IS—4742) **Alloy evaluation for fossil fuel process plants (liquefaction). Quarterly report, January 1-March 31, 1980.** Woods, C.M.; Scott, T.E. (Ames Lab., IA (USA)). May 1980. Contract W-7405-ENG-82. 26p. NTIS, PC A03/MF A01.

A potential drop vs. crack growth calibration curve for dynamically loaded compact tension specimens of A387-74A-Gr.22-Cl.2 steel was established. Fatigue crack growth rates (da/dN) were determined for a wide variation of stress intensity range values (ΔK). Testing was done in moist air (~ 30% RH) at ambient temperature and pressure. Near-threshold to rapid crack growth stages were examined. Corrosion specimens of A387-74A-Gr.22-Cl.2 steel were exposed to a coal slurry environment at 800°F, 4000 psig total pressure for 24, 48, 72 and 240 hours. Corrosion scale growth rates and micrographs of the scale region are presented.

26103 (NBSIR—80-1627, pp 15-48) **Interstitial carbon and nitrogen effects on the tensile and fracture parameters of AISI 303 stainless steels.** Tobler, R.L.; Reed, R.P. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

This study was conducted to determine the effects of carbon and nitrogen on the mechanical properties of an Fe-18Cr-10Ni austenitic stainless steel having a base composition corresponding to AISI 304. Nine steels having carbon plus nitrogen (C + N) contents between 0.067 and 0.325 wt % were tensile tested at 295, 195, 76, and 4 K. J-integral fracture toughness and fatigue crack growth rate tests using 25-mm thick, compact specimens (TL orientation) were also performed at 4 K. At 295 K, the yield stress was linearly dependent on C + N content, with values ranging from 222 to 358 MPa. At cryogenic temperatures, the interstitial strengthening effects were magnified, so that the yield stress values ranged from 329 to 1177 MPa. The fatigue crack growth resistance and fracture toughness decreased with increasing C + N content. The K/sub Ic/ estimates obtained at 4 K ranged from 337 to 123 MPa.m/sup 1/2/, exhibiting an inverse dependence on yield. Measurements of ultimate stress, elongation, and reduction of area are reported, and the role of martensite transformation in these steels is discussed.

26104 (NBSIR—80-1627, pp 49-78) **Temperature dependence of yielding in austentitic stainless steels.** Tobler, R.L.; Reed, R.P.; Burkhalter, D.S. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

The temperature dependence of yielding is discussed with specific reference to austenitic stainless steels. Tensile yield stress (σ/sub y/ measurements at 0.2% plastic strain, a strain rate of 0.02 mm/s, and temperatures between 4° and 295°K are reported for a heat of AISI 316 stainless steel. The results are compared with previously published data for the same heat at elevated temperatures, and the yield stress is observed to decrease from 660 MPa at 4°K to 102 MPa at 922°K. The decrease is regular, with no obvious anomalies, and apparently no low temperature martensitic transformations at 0.2% strain. The merits and limitations of various expressions for describing the temperature dependence of the yield stress are then evaluated.

26105 (NBSIR—80-1627, pp 91-103) **Room-temperature elastic constants and low-temperature sound velocities for six nitrogen-strengthened austenitic stainless steels.** Ledbetter, H.M. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Despite large chemical-composition differences, six nitrogen-alloyed stainless steels show only slight differences in their room-temperataure elastic constants, determined by ultrasonic-velocity measurements. At low temperatures, magnetic transitions cause anomalous elastic-constant behavior and significant differences in elastic constants. Nitrogen content seems not to affect the elastic constants.

26106 (NBSIR—80-1627, pp 105-115) **Sound velocities and elastic constants of austenitic stainless steels 304, 310, and 316.** Ledbetter, H.M. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Room-temperature ultrasonic velocities, longitudinal and transverse, were measured in three AISI 300-series austenitic stainless steels. Elastic constants computed from these velocities show small but significant variations with composition.

26107 (NBSIR—80-1627, pp 117-131) **Elastic constants of stainless steels 304, 310, and 316 between 4 and 295 K.** Ledbetter, H.M. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

For stainless steels 304, 310, and 316, longitudinal and transverse ultrasonic velocities were measured by a pulse-echo method between 295 and 4°K. From these velocities were computed five elastic constants: longitudinal modulus, shear modulus, Young's modulus, bulk modulus, and Poisson's ratio. All three steels show low-temperature elastic constant anomalies.

26108 (NBSIR—80-1627, pp 133-150) **Young's modulus of a copper-stabilized niobium-titanium superconductive wire.** Ledbetter, H.M.; Moulder, J.C.; Austin, M.W. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Young's modulus was determined for a 0.6-mm-dia niobium-titanium superconductive wire. Two methods were used: continuous-wave-resonance and laser-pulse-excitation. Young's moduli were also determined for the components - copper and Nb-Ti - in both wire and bulk forms. Some mechanical-deformation effects on Young's modulus were also measured. From the component' elastic

moduli, that of the composite was predicted accurately by a simple rule-of-mixtures relationship.

26109 (NBSIR—80-1627, pp 153-165) **Weldments for liquid helium service.** McHenry, H.I.; Whipple, T.A. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Research started this year on the evaluation of promising filler metals for improved-toughness stainless steel weldments (but not improved strength), on the evaluation of aluminum alloy weldments, and in the development of improved procedures for measuring fracture toughness at 4°K. Work continued on metallurgical investigations and toughness tests on stainless steel weldments supplied by various contributers to the DOE/OFE superconducting magnet programs. This report summarizes the results obtained in FY79 and briefly outlines the plans for FY80.

26110 (NBSIR—80-1627, pp 167-194) **Fracture behavior of ferrite-free stainless steel welds in liquid helium.** Whipple, T.A.; McHenry, H.I.; Read, D.T. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Most research to date concerning the cryogenic toughness of stainless steel weldments has concentrated on the effects of delta-ferrite content and nitrogen concentration. It has been shown that an increase in either of these leads to reduced cryogenic toughness. This paper reports that a wide variation in fracture toughness occurs in 316L weldments that contain no delta ferrite and only small differences in nitrogen concentration. Therefore, welding parameters and minor compositional variability must also have significant influences. Optical microscopy revealed a strong correlation between cryogenic fracture toughness and fusion-zone grain width, which is controlled by welding parameters and weld-metal composition. An increase in grain size reduces the toughness. Microfissuring, which is a problem in low-ferrite welds, did not have an effect on the measured fracture toughness, but in one cast it severely reduced the tensile ductility. Fatigue crack growth rate tests showed little variation in the fatigue properties of 316L weldments, regardless of the variations in other properties.

26111 (NBSIR—80-1627, pp 195-204) **Weld process study for 316L stainless steel weld metal at cryogenic temperatures.** Kotecki, D.J. (Teldyne McKay, York, PA). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

This report describes the welding procedures used to produce the weldments for NBS evaluation and describes the procedures and test results of the all-weld-metal experiments at Teledyne McKay.

26112 (NBSIR—80-1627, pp 205-216) **Computer-aided J-integral test facility at NBS.** Read, D.T. Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

The computer-aided J-integral testing facility (fracture resistance) that has been implemented at NBS-Boulder over the past year is described briefly.

26113 (NBSIR—80-1627, pp 217-244) **Tensile and notch-tensile properties at room temperature and 4K of welds in aluminum alloy 5083-0 plate.** Kelsey, R.A.; Mueller, L.N. (Alcoa Laboratories, Alcoa Center, PA). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Tensile and notch-tensile data at room temperature and 4°K were obtained for butt welds in 51 mm thick 5083-0 plates donated by five companies. The welds were made by the conventional gas-metal arc welding (GMAW) process and by a high deposition rate GMAW process. The investigation shows that the data are fairly consistent for welds made by the various companies, despite the fact that there were considerable variations in welding procedures. The strengths of the welds are appreciably higher at 4°K than at room temperature. Notch yield ratios, which are an indication of fracture toughness, are quite high, indicating that the welds are very tough.

26114 (NBSIR—80-1627, pp 245-256) **Note on a simple test method for estimaing J/sub Ic/.** Whipple, T.A.; McHenry, H.I. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Fracture toughness testing is generally a time-consuming and expensive procedure; therefore, there has been a significant amount of effort directed toward developing an inexpensive and rapid method of estimating the fracture toughness of materials. In this paper, a simple method for estimating J/sub Ic/ through the use of small, notched, bend bars is evaluated. The test only involves the measurement of the energy necessary to fracture the sample. Initial tests on Fe-18Cr-3Ni-13Mn and 304L stainless steel at 76 and 4°K have yielded results consistent with other fracture toughness tests, for materials in the low- to medium-toughness range.

26115 (ORNL/TM—7255) **Crack propagation in Hastelloy X.** Weerasooriya, T.; Strizak, J.P. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7404-ENG-26. 39p. NTIS, PC A03/MF A01.

The fatigue and creep crack growth rates of Hastelloy X were examined both in air and impure helium. Creep crack growth rate is higher in air and impure helium at 650°C. Initial creep crack growth from the original sharp fatigue crack is by an intergranular mode of fracture. As the cracking accelerates at higher stress intensities, growth is by a mixed mode of both intergranular and transgranular fracture. Fatigue crack growth rate increases with increasing temperature and decreasing frequency for the range of stress intensities reported in the literature and is lower in impure helium than in air.

26116 **Effect of tensile stress on the growth of helium bubbles in an austenitic stainless steel.** Braski, D.N. (Oak Ridge National Lab., TN (USA)); Schroeder, H.; Ullmaier, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung). *J. Nucl. Mater.;* **83**: No. 2, 265-277(Sep 1979).

Foils of the ternary alloy, Fe-17 wt% Cr-17 wt% Ni, were cyclotron-injected with approximately 160 at ppm helium and annealed at 1023 K for times up to 1.74 Ms (482h). Some foils were subjected to tensile stresses which ranged from 9.8 to 27.5 MPa during annealing while others were unstressed. Helium bubbles grew in unstressed specimens at different rates depending on their location in the microstructure; the largest bubbles were found at triple grain junctions, smaller ones of the grain boundaries, and the smallest in the grain matrices. Bubble size in the matrix was approximately proportional to tsup(1/4) for annealing times greater than 2.88 X 10⁴ s (8h). Applied tensile stress accelerated the growth of bubbles, especially at triple grain junctions and grain boundaries. The enhanced growth in these areas appear to be associated with grain-boundary sliding. The number of bubbles in the matrix and on grain boundaries generally decreased with annealing time, suggesting that a migration-coalescence mechanism was also operating.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 26093, 26639, 26714

26117 (CONF-791134—13) **Physical properties of V(Fe,Co,Ni)$_3$ alloys from 300 to 1000°K.** McElroy, D.L.; Williams, R.K.; Weaver, F.J.; Graves, R.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01.

From 16. international thermal conductivity conference; Chicago, IL, USA (7 Nov 1979).

The temperature dependence of the transport properties [thermal conductivity (λ), electrical resistivity (rho), and thermopower (S)] and the thermal expansion coefficients [differential (α_d) and mean (α/sub m/)] were determined in the range 300 to 1000°K for three alloys: water quenched V($Fe_{0.22}Co_{0.78}$)$_3$, ordered V($Fe_{0.22}Co_{0.78}$)$_3$ and ordered V($Fe_{0.6}Ni_{0.4}$)$_3$, modified with Ti. These long-range-ordered alloys have superior structural performance at elevated temperatures/sup 1-4/ and the goal of this study was to determine the ratio, α_o/λ, which is needed to assess the resistance of these experimental alloys to thermal stresses in advanced power system applications.

26118 (COO—4938-3) **Superconductivity in filamentary eutectic composites. Progress report, June 1, 1980-May 31, 1980.** Zaitlin, M.P. (Dartmouth Coll., Hanover, NH (USA). Dept. of Physics and Astronomy). 1980. Contract AC02-78ER04938. 21p. NTIS, PC A02/MF A01.

Measurements of electrical resistivity and magnetic susceptibility have been performed as a function of temperature on samples of Nb-Th eutectic composite. Samples with Nb filament radii as small as 38A were used which is considerably less than the coherence length ξ in Nb of ~ 380A. Surprisingly, measurements of all samples showed a drop in electrical resistance near the transition temperature of bulk Nb and an unmeasurably small resistance by ~ 8K. The magnetic susceptibility showed essentially perfect diamagnetism below ~ 7 to 9K even for samples with the smallest of filament radii. This is in contradiction to theories of the proximity effect which predict a sharp decrease in the transition temperature for samples with a radius smaller than ξ. Some measurements in a static magnetic field have also been made.

26119 (DOE/ER/01023—3) **Study of mechanisms of hydrogen diffusion in separation devices. Third annual report, 1979-1980.** Lee, M.H. (Georgia Univ., Athens (USA). Dept. of Physics). 5 Apr 1980. Contract AS09-77ER01023. 10p. NTIS, PC A02/MF A01.

The main results are in the following three areas: (1) examination of a diffusion model for PdH system, (2) connection between the diffusion model and other physical models, (3) related problems.

Advances made during the third year of this project, particularly in understanding the physical model for hydrogen diffusion, make it possible to begin to meet some of the long-range objectives described in the initial proposals of 1977-1978.

26120 (DOE/ER/10501—1) **Initial stages of oxidation of metals and alloys. Progress report, August 1, 1979-April 30, 1980.** Blakely, J.M. (Cornell Univ., Ithaca, NY (USA)). Apr 1980. Contract AC02-79ER10501. 18p. NTIS, PC A02/MF A01.

An experimental research program on metal surface oxidation has been initiated. Studies of Be and of Fe-Ni single crystal surfaces are underway using the techniques of Auger and electron loss spectroscopy and low energy electron diffraction. A detailed study of the Auger line shape from clean cleaved Be (0001) planes has provided a standard against which all previous work may be composed. Progress has been made in preparing clean Be surfaces by ion sputtering techniques, computer processing of Auger data and some preliminary LEED studies have been made both of clean and oxygen covered surfaces. A liquid nitrogen cold stage for ribbon type single crystal samples has been constructed. The composition of the (100) surface of a Ni-60, Fe-40 single crystal has been investigated over the temperature range from 25 to 900°C. Under uhv conditions only very slight enrichment in Fe occurs. Preliminary studies have also been made of surface structure and of C and S segregation to this Fe-Ni (100) surface.

26121 (LBL—9879) **Plasma enhanced deposition of iron and iron oxide thin films.** Wroge, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 70p. NTIS, PC A04/MF A01.

Thesis.

Plasma enhanced deposition was used to form iron and iron oxide thin films from an iron pentacarbonyl source in a glow discharge, parallel plate reactor. The carbon and oxygen content of the films increased with increasing rf power. The increase in oxygen content was much greater than that of carbon, however, for films deposited at substrate temperature above 200°C. Small crystallites (30 to 300A) of α-Fe and iron oxide (Fe_3O_4 or γ-Fe_2O_3) were formed at substate temperatures of 150°C or above. The concentration of α-Fe crystallites increased with increasing substrate temperature and appeared to decrease with increasing rf power. Magnetic hysteresis was observed for films deposited at temperatures above 150°C. The coercive force ranged from 5 to 45 oersteds, increasing with both increasing substrate temperature and increasing rf power. The specific magnetization at saturation decreased from 2 to 0.4 weber-meter/kilogram by increasing the rf power from 10 to 100 watts. Square hysteresis loops (B/sub r//B/sub s/ $\simeq$ 1) were observed for a substrate temperautre of 300°C and rf power levels above 30 watts. The magnetization, M Vector, was found to lie in the film plane.

26122 (NBSIR—80-1627, pp 79-89) **Anomalous low-temperature elastic-constant behavior in Fe-13Cr-19Mn.** Ledbetter, H.M. (National Bureau of Standards, Boulder CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low tempertures. III.

Elastic constants determined by sound-velocity measurements in an Fe-13Cr-19Mn steel show anomalous temperature behavior around 274 K, indicating a paramagnetic-antiferromagnetic transition.

26123 (SAND—79-2350C) **Electronic properties of silicon grain boundaries.** Pike, G.E.; Seager, C.H. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 24p. (CONF-800430—2). Dep. NTIS, PC A02/MF A01.

From Conference on physics of fiber optics; Chicago, IL, USA (28 Apr 1980).

Polycrystalline silicon is a clean and relatively simple prototype of electronic ceramics. The theory of the electrostatic barriers which form at silicon grain boundaries will be discussed. The use of experimental conductance and capacitance measurements to obtain the barrier height and energy density of grain boundary states will be illustrated.

26124 **Temperature dependence of the soft-x-ray emission edges of simple metals.** Tagle, J.A.; Arakawa, E.T.; Callcott, T.A. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4552-4557(15 May 1980).

The widths and energy positions of the M/sub 2,3/-emission edge of potassium, K-emission edge of beryllium, and L/sub 2,3/-emission edges of aluminum and magnesium have been measured for temperatures between 80 and 600 °K. All band edges broaden ($\Delta\Gamma$) and shift in energy (ΔE) with increasing temperatures for these materials. Similar results were reported earlier for the Li K-emission edge and Na L/sub 2,3/ edge. Lattice-relaxation processes and the phonon core-hole interaction are the dominant mechanisms affecting the core-level widths and the experimentally observed edge widths. The edge shifts are found to be proportional to the thermal expansion of the lattice, and are discussed in terms of the electron energy-level shifts which occur as the lattice dilates.

26125 **Surface states, surface magnetization, and electron-spin polarization: Ni(001).** Wang, C.S.; Freeman, A.J. (Physics Department and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4585-4591(15 May 1980).

Results are presented of the first ab initio self-consistent spin-polarized energy-band study of a ferromagnetic transition-metal film [Ni(001)] that is thick enough (nine layers) to accurately determine the energy dispersion and spatial character of surface states and their effects on the surface spin polarization, surface magnetic moments, and average exchange splittings. Band structures and surface states, layer density of states, and charge and spin densities are presented and used to discuss a number of experiments. We find no evidence for magnetically "dead layers" on Ni(001) surfaces. The surface-layer magnetic spin moment is reduced by 20% from the center-layer magnetic moment (which has the bulk value) due to a majority-spin d-hole surface state at M-bar which lies just above the Fermi energy.

26126 **Acceptor complexes in germanium: Systems with tunneling hydrogen.** Haller, E.E.; Joos, B.; Falicov, L.M. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4729-4739(15 May 1980).

Experimental data on photothermal ionization spectroscopy of hydrogen-related acceptors in ultrapure germanium are presented. Ground levels do not split under applied uniaxial stresses. A theoretical model based on dynamic tunneling of hydrogen is proposed and analyzed in detail. An overall chemical picture of impurities associated with hydrogen: acceptors and donors: is also presented. It accounts consistently for all known facts related to these complexes: infrared spectra, thermal annealing and quenching, and conditions of crystal growth.

26127 **Fluxoid pinning by small nitride precipitates in niobium.** Kerchner, H.R.; Narayan, J.; Christen, D.K.; Sekula, S.T. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev. Lett.;* **44**: No. 17, 1146-1149(28 Apr 1980).

The magnetic hysteresis of superconducting niobium single crystals containing ~ 80-A-diam nitride precipitates was investigated. Introducing precipitates into the samples produced no significant change in the critical-current density J/sub c/ except near the critical fields H/sub c/1 and H/sub c/2. The samples trapped flux below H/sub c/1 and exhibited dramatic peaks in J/sub c/ within 3% of H/sub c/2. These observations are interpreted as clear evidence of a threshold for fluxoid pinning, and reasonable agreement with theory is obtained.

26128 **Diffusivity and solubility of fluorine in solid nickel from electrochemical measurements.** Reddy, S.N.S.; Rapp, R.A. (Ohio State Univ., Columbus). *Metall. Trans., B;* **11**: No. 1, 99-106(Mar 1980).

The diffusivity and solubility of fluorine in solid nickel were determined using the following solid-state electrochemical cells: Co + CoF_2/BaF_2/Ni/BaF_2/Co + CoF_2 and Co + CoF_2/CaF_2/BaF_2/Ni/BaF_2/CaF_2/Co + CoF_2. In the temperature range of 1023 to 1223°K, the diffusion coefficient of fluorine in solid nickel is given by: D/sub F/(cm^2/s) = (2.13/sup +5.54//sub -1.54/) x 10^{-3}exp((-118,600 +- 12,000 J/mol)/RT. The dissolution of atomic fluorine in solid nickel obeys Sieverts' law; however, the solubility results showed considerable scatter. In the temperature range 1073 to 1223°K, the mean solubility of fluorine in solid nickel, corresponding to the equilibrium Ni + NiF_2, follows the relationship: N/sub F// sup S/(at. pct) = 5.73 x 10^{-3} exp((10,850 J/mol)/RT)

26129 **Electrochemical investigation of solubility and chemical diffusion of lithium in aluminum.** Wen, C.J. (Stanford Univ., CA); Boukamp, B.A.; Huggins, R.A.; Weppner, W. *Metall. Trans., B;* **11**: No. 1, 131-137(Mar 1980).

The solubility of lithium in aluminum and the chemical diffusion coefficient in this solid solution have been investigated as a function of temperature between 400 and 600°C using the electrochemical cell: (-)Al, LiAl/LiCl-KCl(eut.)/Al(Li)(+). The solubility limit of lithium in aluminum was found to decrease from 13.8 at. pct at 595°C to 8.0 at. pct at 395°C, in good agreement with data previously reported by other investigators using different techniques. The chemical diffusion coefficient has been measured by two different electrochemical transient techniques. The data can be represented by the relation: tilde D = 0.155 exp (-ΔH/RT) cm^2/s where ΔH is 119.2 kJ/mol. This electrochemical technique has also been used to obtain values of the composition dependence of the Gibbs free energy of mixing and the enhancement factor d in a/sub Li/dlnX/sub Li/ which relates the chemical diffusion coefficient and the self diffusion coefficients within the Li-Al solid solution.

26130 Electronic and structural studies of the hydrides of $ErFe_2$ from ^{57}Fe and ^{166}Er Moessbauer spectroscopy. Viccaro, P.J.; Shenoy, G.K.; Dunlap, B.D.; Westlake, D.G.; Miller, J.F. (Argonne National Lab., IL (USA)). *J. Phys. (Paris), Colloq.;* No. 2, C2.198-C2.201(1979).

From 8. International conference on applications of the Moessbauer effect; Kyoto, Japan (28 Aug - 1 Sep 1978).

Two different hydrides of the C15 Laves phase intermetallic $ErFe_2$ are considered. For $ErFe_2Hsub(3.65)$, X-ray analyses showed the presence of an expanded C15 cubic phase and a lower symmetry phase. The ^{57}Fe mean saturated hyperfine field is 20% larger than in $ErFe_2$ and the ^{166}Er hyperfine field is 15% smaller. These results coupled with previous measurements of the net moment imply that the Er-Fe coupling is not antiparallel in this hydride. For $ErFe_2Hsub(4.12)$, the only phase detected was rhombohedral. The Moessbauer results indicate a magnetic transition temperature between 1.7 K and 4.2 K and a drastic reduction of the Fe moment in this hydride.

26131 Superconducting critical field and low temperature heat capacity of americium. Smith, J.L.; Stewart, G.R.; Huang, C.Y. (Los Alamos Scientific Lab., NM (USA)); Haire, R.G. (Oak Ridge National Lab., TN (USA)). *J. Phys. (Paris), Colloq.;* No. 4, C4.138-C4.139(1979).

From 3. International conference on electronic structure of the actinides; Grenoble, France (30 Aug - 1 Sep 1978).

Low temperature measurements on the superconductor americium yield an electronic heat capacity coefficient of $\gamma = 2 +- 2mJ/$ mole. K^2 and a critical field of H/sub c/ (0) approximately 500 Oe. The former is rather small while the critical field is unexpectedly large.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 25272, 25274, 25456, 25457, 25642, 25869, 26102, 26242

26132 (AD-A—077660/9) **The effect of plastic deformation on the transport of hydrogen in nickel. Tehnical report.** Kurkela, M.; Latanision, R.M. (Aeroprojects, Inc., West Chester, PA (USA)). Sep 1979. Contract N00014-78-C-0002. 9p. NTIS, PC A02/MF A01.

The permeation of hydrogen into crystalline metals may occur in part by lattice diffusion, by grain boundary (or other short circuit) diffusion, or, in the case of specimens undergoing plastic deformation, by dislocation transport. In this work, electrochemical permeation measurements indicate that the apparent diffusivity of hydrogen is increased by several orders of magnitude when permeation specimens are plastically deformed and simultaneously charged with hydrogen.

26133 (COO—4993-2) **Investigation of dispersed iron alloy catalysts in the carbon monoxide-hydrogen synthesis reaction. Progress report, August 1, 1979-July 31, 1980.** Butt, J.B.; Schwartz, L.H. (Northwestern Univ., Evanston, IL (USA)). Apr 1980. Contract AC02-78ER04993. 12p. NTIS, PC A02/MF A01.

A series of Fe-Ni, Fe-Co, Fe-Cu and Fe-K catalysts supported on SiO_2 have been prepared, characterized, and investigated with respect to activity and selectivity in CO-H_2 synthesis. In addition, several silica supported iron nitrides have been prepared and characterized. During the period encompassed by this report, our catalyst characterization activities have been directed toward the identification of the particle sizes and phases formed upon preparation, calcination, reduction and carburization. We have employed a combination of methods in doing these characterizations: transmission electron microscopy, x-ray diffraction, Moessbauer spectroscopy and temperature programmed oxidation-reduction. Study of the activity and selectivity of the catalyst series has been carried out in a differential reactor system in the range of 225 to 300°C with 3H:CO stoichiometry. We have also been developing a hydrogen uptake procedure for determining exposed surface in supported iron catalysts. It has been found that the conditions of preparation strongly affect the nature of the resulting catalyst, both with respect to alloy homogeneity, metal particle size, and catalytic activity. For the Fe system in particular, standard methods of preparation via impregnation and calcination result in very large particle (ca.80 nm) composites of smaller individual grains (ca.10 nm). characterization via x-ray or Moessbauer, however, reveals only the characteristic dimension of the granules and not of the composite particles.

26134 (GA-A—15673) **Effects of surface condition on the corrosion of candidate structural materials in a simulated HTGR-GT environment.** Thompson, L.D. (General Atomic Co., San Diego, CA (USA)). Feb 1980. Contract EY-76-C-03-0167-065. 107p. NTIS, PC A06/MF A01.

A simulated high-temperature gas-cooled reactor (HTGR) helium environment was used to study the effects of surface finish conditions on the subsequent elevated-temperature corrosion behavior of key candidate structural materials. The environment contained helium with 500 μatm H_2/50 μatm CO/50 μatm CH_4/<0.5 μatm H_2O at 900°C with total test exposure durations of 3000 hours. Specimens with lapped, grit-blasted, pickled, and preoxidized surface conditions were studied. Materials tested included two cast superalloys, IN 100 and IN 713LC; one centrifugally cast high-temperature alloy, HK 40 one oxice-dispersion-strengthened alloy, Inconel MA 754; and three wrought high-temperature alloys, Hastelloy Alloy X, Inconel Alloy 617, and Alloy 800H.

26135 (GA-A—15790) **Carburization of austenitic alloys by gaseous impurities in helium.** Lai, G.Y.; Johnson, W.R. (General Atomic Co., San Diego, CA (USA)). Mar 1980. Contract AT03-76ET35300. 48p. NTIS, PC A03/MF A01.

The carburization behavior of Alloy 800H, Inconel Alloy 617 and Hastelloy Alloy X in helium containing various amounts of H_2, CO, CH_4, H_2O and CO_2 was studied. Corrosion tests were conducted in a temperature range from 649 to 1000°C (1200 to 1832°F) for exposure time up to 10,000 h. Four different helium environments, identified as A, B, C, and D, were investigated. Concentrations of gaseous impurities were 1500 μatm H_2, 450 μatm CO, 50 μatm CH_4 and 50 μatm H_2O for Environment A; 200 μatm H_2, 100 μatm CO, 20 μatm CH_4, 50 μatm H_2O and 5 μatm CO_2 for Environment B; 500 μatm H_2, 50 μatm CO, 50 μatm CH_4 and < 0.5 μatm H_2O for Environment C; and 500 μatm H_2, 50 μatm CO, 50 μatm CH_4 and 1.5 μatm H_2O for Environment D. Environments A and B were characteristic of high-oxygen potential, while C and D were characteristic of low-oxygen potential. The results showed that the carburization kinetics in low-oxygen potential environments (C and D) were significantly higher, approximately an order of magnitude higher at high temperatures, than those in high-oxygen potential environments (A and B) for all three alloys. Thermodynamic analyses indicated no significant differences in the thermodynamic carburization potential between low- and high-oxygen potential environments. It is thus believed that the enhanced carburization kinetics observed in the low-oxygen potential environments were related to kinetic effects. A qualitatively mechanistic model was proposed to explain the enhanced kinetics. The present results further suggest that controlling the oxygen potential of the service environment can be an effective means of reducing carburization of alloys.

26136 (SAND—80-1170C) **Glass ceramics for explosive device headers.** Ballard, C.P.; Eagan, R.J.; Kjeldgaard, E.A. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 20p. (CONF-800713—10). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The desired features of a header for our advanced explosive devices include small size; 700 Mpa static burst strength; corrosion resistant alloys for electrodes, bridgewire, and housing; integral charge holder; high thermal conductivity (approaching that of alumina ceramic); no braze around the electrodes; design flexibility and quick turnaround time for fabrication of development prototypes; and low cost.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 26740

26137 (CONF-800609—2) **Applications of the theory of cavity growth to dual-ion swelling experiments.** Hayns, M.R.; Mansur, L.K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The rate theory of cavity growth is applied to study the effects of helium gas on cavity swelling. The variation of swelling with temperature is emphasized: (1) expressions are derived showing that the primary effect of the helium is in pressurizing cavities and that a secondary effect is in altering the microstructural sink strengths. The expressions simplify in the parameter range of engineering interest such that the temperature regime of swelling is predicted to shift upward in approximately direct proportion to the cavity gas pressure; (2) recent experimental data on swelling of a pure stainless steel type alloy under dual-nickel and helium-ion bombardment is interpreted. Helium-free, helium-coimplanted, and helium-preimplanted swelling results can be explained by the theory. It is necessary to account for the partitioning of the helium to dislocations as well as to cavities in order to explain the experimental results for helium coimplantation; (3) model studies for physically reasonable parameters reveal the importance of the He/dpa ratio.

26138 (DOE/ER/03158—82) **Single atom sputtering events: direct observation of near-surface depleted zones in ion-irradiated tungsten.** Current, M.I.; Wei, C.Y.; Seidman, D.N. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering; Cornell Univ., Ithaca, NY (USA). Materials Science Center). Mar 1980. Contract AS02-76ER03158. 62p. NTIS, PC A04/MF A01.

The three-dimensional spatial arrangement of vacancies contained in depleted zones (DZs), of ion-irradiated tungsten specimens, was determined with atomic resolution by the field-ion microscope (FIM) technique. These DZs were detected in the near-surface region of specimens which had been irradiated in situ at ≦15 K with 20 keV W^+, 30 keV W^+, Kr^+, Cu^+, or Ar^+ ions. The values of the ion dose employed were small (≦ 10^{13} ions cm^{-2}); therefore, each DZ analyzed was the result of the impact of a single projectile ion. At the irradiation temperature (≦ 15°K) both the self-intersititial atoms and vacancies were immobile, so that the primary state of radiation damage was preserved. The following properties of each DZ were determined: the total number of vacancies; the number of vacancies in the near-surface region; the spatial extent - that is, the dimensions required to determine a volume; the average vacancy concentration; the average vacancy concentration associated with the non-surface region; the first-nearest neighbor cluster distribution for the vacancies in the near-surface region; the radial distribution function of all the vacancies; the distribution of vacancies as a function of depth normal to the irradiated surface; and the sputtering yield. Most of the above properties of the near-surface DZs had similar values to those of the DZs detected in the bulk of the FIM specimens. The total number of vacancies detected in the near-surface region wasapproximately consistent with theoretical estimates of the average sputtering yield. The sputtering yield of individual DZs exhibited significant fluctuations from the measured average sputtering yield.

26139 (SAND—80-0831C) **Transient effects of ionizing radiation in Si, InGaAsP, GaAlSb, and Ge photodiodes.** Wiczer, J.J.; Barnes, C.E.; Dawson, L.R. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 14p. (CONF-800307—4). Dep. NTIS, MF A01.

From Fiber optic in the nuclear environment symposium; Adelphi, MD, USA (25 Mar 1980).

Portions of document are illegible.

Certain military applications require the continuous operation of optoelectronic information transfer systems during exposure to ionizing radiation. In such an environment the optical detector can be the system element which limits data transmission. We report here the measured electrical and optical characteristics of an irradiation tolerant photodiode fabricated from a double heterojunction structure in the gallium aluminum antimonide (GaAlSb) ternary semiconductor system. A series of tests at Sandia Laboratories' Relativistic Electron Beam Accelerator (REBA) subjected this device and commercially available photodiodes (made from silicon, germanium, and indium gallium arsenide phosphide) to dose rate levels of 10^7 to 10^9 rads/sec. The results of these tests show that the thin GaAlSb double heterojunction photodiode structure generates significantly less unwanted radiation induced current density than that of the next best commercial device.

26140 **Effects of prior stress history on the irradiation creep of 20% cold-worked AISI 316 stainless steel.** Chin, B.A.; Straalsund, J.L.; Wire, G.L. (Hanford Engineering Development Lab., Richland, WA (USA)). *J. Nucl. Mater.;* **83**: No. 2, 324-329(Sep 1979).

The following conclusions resulted from this study: An in-reactor transient component of creep is found to occur whenever the stress level is increased. The transient is principally a thermal process, short in duration, and only weakly dependent on flux. The observed irradiation component of in-reactor creep is independent of prior stress history. Microstructural development during irradiation is influenced predominantly by the irradiation flux and temperature variables, and only to a minor extent by the irradiation stress history.

26141 **Simulation of fusion reactor first wall enhanced diffusion by fission fragment irradiation of α-brass.** Guinan, M.W.; Violet, C.E.; Kinney, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Damask, A.C. *Radiat. Eff.;* **40**: No. 4, 209-220(Mar 1979).

Enhanced diffusion in α-brass was measured during irradiation with ^{235}U fission fragments and the results compared with previous work that used fission-reactor neutrons and 14.8 MeV neutrons. Calculations of damage energy from these three sources in copper correctly predicted the ratios of observed enhanced diffusion rates. Further calculations showed that the recoil spectrum from fission fragments better approximates the spectrum expected in the first wall of the fusion reactor than do the spectra from either neutron source.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 25122, 25152

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 25348, 25349, 26015, 26029, 26032, 26035, 26201

26142 (COO—4441-3) **Progress report on inelastic deformation in crystalline non-metallic materials.** Kohlstedt, D.L. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering). Apr 1980. Contract AS02-77ER04441. 46p. NTIS, PC A03/MF A01.

Densification of polycrystalline TiC was studied during hot-pressing and sintering of powders. Starting powders of Ti plus C, TiC, and TiC plus Ti have been reacted at 1700 to 1835°C above the melting point of Ti metal (T/sub m/ = 1675°C for Ti). The bulk C:Ti ratio was maintained in the range 0.97 to 0.6 in order to allow the possibility of producing a single phase material. All of the resulting microstructures, examined in the scanning electron microscope, contain press both along the grain boundaries and within the grains. However, the samples fabricated from Ti metal plus TiC contain substantially fewer pores than those produced from TiC powder alone. Debye-Scherrer x-ray diffraction analyses demonstrate that in the TiC plus Ti runs, all of the Ti is transformed to substoichiometric TiC after a few minutes at 1800°C. While sintering time and temperature have a small influence on the final density, increasing the weight percent of Ti metal added to TiC dramatically increases the final density and the hardness.

26143 (DOE/ER/10413—1) **Study of solid metal/ceramic reactions. Progress report, June 18, 1979-March 17, 1980.** Mehan, R.L.; Jackson, M.R. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 26 Feb 1980. Contract AC02-79ER10413. 40p. NTIS, PC A03/MF A01.

Using a model superally containing Ni, Cr, an Al, experiments and analysis represent the beginning of an attempt to gain a fundamental understanding of ceramic-metal reactions, SiC and Si_4N_4 were the ceramics used. (FS)

26144 (SAND—79-2167C) **Low temperature CVD of TaB_2.** Randich, E. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 20p. (CONF-800439—1). Dep. NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Crystalline TaB_2 has been deposited using the CVD reaction of $TaCl_5$ and B_2H_6 in the temperature range of 773-1200°K. Thermodynamic calculations have been made which compare the use of both B_2H_6 and BCl_3 as B source gases. The deposits obtained with B_2H_6 exhibited extremely small crystal size and contained amorphous B when the deposition temperature was below ~ 873°K but were substoichiometric in B above this temperature. Carbon analysis indicated that C may substitute for B and thereby stabilize the diboride structure at high deposition temperatures. Microhardness of the coatings decreased with increasing B/Ta ratio and decreasing crystal size.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 25790, 26015, 26142, 26144

26145 (DOE/ER/05002—11) **Kinetic processes at grain boundaries. Progress report, 15 August 1979-14 August 1980.** Balluffi, R.W. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). May 1980. Contract AS02-78ER05002. 24p. NTIS, PC A02/MF A01.

A broad investigation was made of kinetic processes at grain boundaries and the relationship between these kinetic processes and the boundary structure. The approach was both experimental and theoretical. Extensive use was made of high resolution experimental methods of investigating grain boundaries in specimens containing boundaries of controlled geometry. Computer simulation was also employed. Elements of the following projects were completed: a study of intrinsic and extrinsic secondary grain boundary dislocation structure in [001] high angle twist boundaries in MgO; a study of grain boundary dislocations in plane matching grain boundaries; an analysis and review of high angle grain boundaries as sources or sinks for point defects; an analysis and review of grain boundary structure in metals and ceramic oxides; and simulation of the structure of vacancies in high angle grain boundaries. Progress was made: in the development of a model for diffusion induced grain boundary migration; and the determination of the mechanism for grain boundary diffusion in metals.

26146 **Thermodynamic calculations on coal ash and CaO interactions.** Besmann, T.M. (Oak Ridge National Lab., TN); Lindemer, T.B.; Ling, C. *Am. Ceram. Soc. Bull.;* **59**: No. 4, 484-485(Apr 1980).

In a fluidized-bed combustor, coal and limestone particles are suspended by flowing air in which the coal burns. At high temperatures (typically 1100°K), the limestone reacts with SO_2 generated by combustion of sulfur in the coal and forms $CaSO_4$. However, coal ash is present in addition to the coal and limestone and, should it interact significantly with the $CaSO_4$, may influence the sulfur fixation. Thermodynamic equilibrium calculations were performed with the major ash elements of aluminum, silicon, and iron to predict

phase equilibria and SO_2 partial pressures as a function of oxygen partial pressure, P/sub O_2/, and temperature, T(K). The equilibrium calculations were made using a computer program that calculates equilibrium relations in complex chemical systems.

26147 Calculated n-beam crystal structure images of oxides based on fluorite and ReO_3 and the interpretation of observed images. Skarnulis, A.J.; Summerville, E.; Eyring, L. (Arizona State Univ., Tempe). *J. Solid State Chem.;* **23**: No. 1-2, 59-71(15 Jan 1978).

Dynamical n-beam calculations are used to explore the potential of crystal structure imaging for investigating superstructures in fluorite-related systems. Crystal structure images of M_7O_{12} phases are investigated under various conditions of crystal thickness and defect of focus, and it is shown that under some conditions crystal structure images show direct structural correlation. In others where the structural correlation is missing the calculated and observed images still agree. Two programs, FCOEFF and DEFECT, which allow calculation of images of structures with any symmetry and in any projection, are tendered. The n-beam calculations on a number of ReO_3-based structures are also presented to demonstrate the versatility of the programs. 9 figures.

26148 Phase diagram of the system Li_2CrO_4-K_2CrO_4. Karnowsky, M.M.; Clark, R.P.; Biefeld, R.M. (Sandia Labs., Albuquerque, NM). *J. Solid State Chem.;* **23**: No. 1-2, 219-223(15 Jan 1978).

The Li_2CrO_4-K_2CrO_4 phase diagram was determined by use of differential thermal analyses with confirmation by high-temperature x ray diffraction. The outstanding features are the formation of a eutectic composition of ~ 22.5 mole % K_2CrO_4 between Li_2CrO_4 and the doublet salt, δ-$Li_2CrO_4.K_2CrO_4$, at 390°C; the formation of a congruently melting double salt $Li_2CrO_4.K_2CrO_4$ with three solid state allotropic forms, γ, δ, and epsilon, the d spacings and colors of which are given; and the formation of a eutectic composition at ~ 54 mole % K_2CrO_4 between αK_2CrO_4 and the doublet salt, γ-$Li_2CrO_4.K_2CrO_4$, at 525°C. 2 figures, 2 tables.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 25141, 26029, 26143, 26144, 26153

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 26015, 26020, 26146

26149 (BDX—613-2436) **Plasma cleaning, end-of-process detection.** Smith, M.D. (Bendix Corp., Kansas City, MO (USA)). May 1980. Contract AC04-76DP00613. 13p. (CONF-800636—1). NTIS, PC A02/MF A01.

From Adhesives in industry conference; El Segundo, CA, USA (24 Jun 1980).

Activated gas plasma is being used extensively to remove trace organic contamination from electromechanical components prior to final assembly. Optical emission techniques are being used throughout the electronics industry to determine end-points of plasma processes for removing large amounts of photo-resist. The application of these techniques to detect the removal of trace organic residues was shown to be possible using a borrowed process monitor. Removal of organic contamination as low as 5 mg total was detected in an oxygen plasma. Auger analysis confirmed the cleanliness levels indicated by the end-point detector tested. The simplicity of this type of process monitor lends itself to production line use for the plasma cleaning of various parts and batch sizes. The monitoring of argon plasma cleaning processes using optical emission techniques has also been investigated.

26150 Some aspects of the high temperature vaporization behavior and valence effects in actinide-oxide rare-earth-oxide systems. Tetenbaum, M. (Argonne National Lab., IL (USA)). *Rev. Int. Hautes Temp. Refract.;* **15**: No. 3, 253-258(1978).

From International colloquium on the refractory oxides for energy lines at high temperature; Odeillo, France (28 Jun - 1 Jul 1977).

The vaporization behavior of the neodymium sesquioxide phase has been studied as a function of oxygen partial pressure in the temperature range from 2155 to 2485°K. Oxygen potentials for the U-Nd-O system, where Nd/(U+Nd)=0.1 and 0.2 are higher than those obtained with unalloyed urania. A significant increase in oxygen potential occurs when cerium is incorporated into the lattice of the U-Pu-O system for actinide ratio of Pu/(U + Pu)=0.2 and cerium-to-metal ratio Ce/(U + Pu +Ce)=0.05. Measurements of oxygen potential at 2050°K above hypostoichiometric U-Pu-O compositions having plutonium-to-metal ratios ranging from 0.15 to 0.30 indicate that for a given plutonium valence, the oxygen potential is dependent on the plutonium-to-metal ratio. Total pressures of actinide-bearing species estimated from our experimental oxygen potentials and the free energies of formation of the gaseous and condensed phases are in good agreement with those obtained from analysis of sublimates collected during transpiration experiments.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 25139, 25166, 26014, 26136

26151 (FE—2612-15) **Advanced coal-fueled combustor/heat exchanger technology study: key features analysis.** Campbell, J.C. Jr. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Jun 1978. Contract EF-77-C-01-2612. 53p. NTIS, PC A04/MF A01.

An examination the four preliminary designs and of their key features suggests that they represent extensions of the extensive existing steam boiler technology. None of the concepts represents a completely new technology. The identified key features relate to specific aspects of the designs. This condition provides some confidence that the required combustor/heat exchanger technology development will be achievable. The CCGT combustor/heat exchanger technology task, for instance, is obviously much less all-encompassing than the MHD system task or the nuclear fusion development task. The key features relating to combustion technology and high-temperature metals applications provide a sense of achievability. Some compromises may be necessary on working fluid temperature or pressure levels or delta P allowances, but there is a sense that adequate design will be achievable by the application of relatively straightforward R & D effort. The challenge with these features is to achieve economic as well as technical viability. It is the cost of the alloys necessary for survival that is crucial. The 1750°F and higher preliminary designs rely so completely upon achieving satisfactory performance from ceramic materials that there is a real question as to their ultimate technical feasibility, notwithstanding cost effects.

26152 Degradation studies on erbium dideuteride thin films. Antepenko, R.J.; Holloway, D.M. (Chemistry Laboratory, General Electric Company, Neutron Devices Department, P.O. Box 11508, St. Petersburg, Florida 33733). DE-AC04-76DP 00656. *Appl. Spectrosc.;* **34**: No. 2, 206-211(Mar 1980).

Rare earth metals are used as hydrogen isotope occluders and function as electrodes in neutron generator tubes. In this study, erbium dideuteride thin films have been quantitatively measured for purity in order to establish the deleterious effects resulting from film processing. These processes include deposition, hydriding, and neutron tube vacuum anneal. The data taken reveal that ~0.02 mg/cm^2 erbium metal is unavailable as the hydride due to surface oxidation and interfacial interactions between ocluder metal and substrate.

RADIATION EFFECTS

26153 (SAND—80-1228C) **Effects of plasma-deposited silicon nitride passivation on the radiation hardness of CMOS integrated circuits.** Clement, J.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 12p. (CONF-800637—1). NTIS, PC A02/MF A01.

From Plasma symposium; San Francisco, CA, USA (19 Jun 1980).

The use of plasma-deposited silicon nitride as a final passivation over metal-gate CMOS integrated circuits degrades the radiation hardness of these devices. The hardness degradation is manifested by increased radiation-induced threshold voltage shifts caused principally by the charging of new interface states and, to a lesser extent, by the trapping of holes created upon exposure to ionizing radiation. The threshold voltage shifts are a strong function of the deposition temperature, and show very little dependence on thickness for films deposited at 300°C. There is some correlation between the threshold voltage shifts and the hydrogen content of the PECVD silicon nitride films used as the final passivation layer as a function of deposition temperature. The mechanism by which the hydrogen contained in these films may react with the Si/SiO_2 interface is not clear at this point.

26154 Swelling and thermal diffusivity changes in neutron-irradiated ceramics. Hurley, G.F.; Bunch, J.M. (Los Alamos Scientific Lab., NM). *Am. Ceram. Soc. Bull.;* **59**: No. 4, 456-458(Apr 1980).

Fifteen forms of ten oxide, nitride, or oxynitride materials were irradiated in EBR-II to 2.8 x 10^{21} n/cm^2 (E/sub n/ > 0.1 MeV) at 1015°K (740°C). Of these materials, only those based on Al_2O_3 or BeO showed volume swelling >0.5%. Ceramics based on $MgAl_2O_4$, $Y_3Al_5O_{12}$, Y_2O_3, Si_3N_4, sialon, and Si_2ON_2 exhibited 0 to 0.5 vol% swelling. Most of these materials underwent large thermal diffusivity reductions, of the order of 30 to 70%. Single-crystal spinel was notable in displaying almost no damage, as evidenced by lack of changes in volume or thermal conductivity, or defects visible by TEM.

COMPOSITE MATERIALS

26155 (NBSIR—80-1627, pp 415-424) **Structures, insulators, and conductors for large superconducting magnets.** Fickett, F.R. (National

Bureau of Standards, Boulder, CO); Reed, R.P.; Dalder, E.N.C. Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

As the size of superconducting magnet systems increases, the structural aspects become of increasing importance. Because the stresses increase rapidly with size and field, magnets of the type proposed for new devices will be largely structure. We are engaged in a program to acquire low temperature mechanical and physical property data on a wide range of materials. The present status of this data base is reviewed and results from our test program are described. We have placed emphasis on the austenitic stainless steels as the primary structural material, although data have also been acquired on a few aluminum alloys. Particular stress has been placed on the fracture characteristics of both the base metal and weldments where appropriate. Achieving a good match between weld and base metal at 4°K is proving to be a difficult task. Several industrial fiberglass-epoxy laminates of fixed composition have been produced as a result of this program. These materials, G10-CR, G11-CR, and G11-CR(BF) have been tested at 4°K and the results are presented. Recent measurements on the effect of stress and fatigue on matrix materials for superconductor stabilization are also briefly reviewed. A new handbook of data on the properties of structural materials for superconducting magnet systems is described.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 26032

26156 One-directional uniformly coated fibers, method of preparation, and uses therefor. Newkirk, L.R.; Valencia, F.A.; Riley, R.E.; Wallace, T.C. Sr. US Patent Application 061,671. [nd]. 32p.

A problem addressed by this invention was how to obtain very long lengths of refractory metal-coated multifilamentary yarns having a uniform coating on the filaments which make up each yarn, the coating being uniform throughout the length of the yarn such that the coated yarns are suitable for being woven and are suitable for a variety of other uses. The solution is a continuous process which employs a chemical vapor deposition reaction at relatively low temperature and pressure and a separation of the gaseous reaction products from the coated yarn prior to allowing the coated yarn to cool.

STRUCTURE AND PHASE STUDIES

26157 (LBL—10689) **Chemical and structural characterization of thermally degraded black chrome.** Lampert, C.M.; Washburn, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 8p. (CONF-800604—24). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The very popular black chrome coating, Harshaw Chemical Company's Chromonyx, was characterized in terms of materials science to determine the nature of its microstructure and contribution to solar selectivity. The properties and degradation mode were revealed for samples heat treated at high temperatures. Principally, transmission and scanning electron microscopy, scanning Auger and energy dispersive X-ray analysis were employed for this microstructural characterization.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 26156

26158 (COO—4027-3) **Probabilistic models of the stress-rupture of composite materials: Phase III. Progress report, June 15, 1978-June 14, 1980.** Phoenix, S.L. (Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering). Mar 1980. Contract EY-76-S-02-4027. 34p. NTIS, PC A03/MF A01.

The development of static and time dependent models for the failure of composite materials has been pursued. These models are based on the chain-of-bundles probability model for composite failure wherein local load sharing among non-failed fiber elements in a bundle plays a key role. At the outset, it was believed that the static model was well developed in the literature by others, and that work on the time dependent versions could proceed. In these versions, the viscoelasticity of the matrix was to be the cause of the time effects. Unfortunately, initial studies showed the published analysis on the static case to be superficial, and a rigorous extension to the time dependent case was not possible. A thorough investigation of the static model was carried out. Sophisticated analytical and numerical techniques were developed to treat the static model, and these show promise of being extendable to the time dependent case. Exact analysis has been performed on composites with few fibers to gain insight, and a powerful recursive technique has been developed to treat composites of larger sizes.

26159 (NBSIR—80-1627, pp 263-331) **Cryogenic properties of filamentary-reinforced composites: an update.** Kasen, M.B. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Current knowledge of the effect of cryogenic temperatures on the mechanical, elastic, thermal, and electrical properties of reinforced plastic laminates is reviewed. Directions of fundamental research and of test method development are defined and discussed. Recommendations are made for effective future research. It is confirmed that conventional laminates developed for room temperature service are viable engineering materials at cryogenic temperatures. Averages of mechanical and elastic properties increase on cooling. But increased variability in strength properties on cooling remains a problem. This variability reflects the increasing notch sensitivity of the matrix resins on cooling.

26160 (NBSIR—80-1627, pp 333-339) **Mechanical properties of G-10CR and G-11CR.** Schramm, R.E.; Kasen, M.B. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

The last report contained mechanical characterization data at 295, 76, and 4°K in the warp and normal directionf for G-10CR and G-11CR from manufacturer A's pilot plant. This characterization has now been completed for the fill direction. The results of all the individual tests are given.

26161 (NBSIR—80-1627, pp 341-366) **Mechanical, electrical, and thermal characterization of G-10CR and G-11CR glass cloth/epoxy laminates between room temperature and 4°K.** Kasen, M.B.; MacDonald, G.R.; Beekman, D.H.; Schramm, R.E. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Properties studied include tensile strength, elongation, modulus, Poisson's ratio, and compressive strength. Interlaminar shear strength was characterized by both guillotine and short beam methods. The effect of orientation was examined. The data indicate that both laminate types are excellent cryogenic materials. Additionally, we have screened the mechanical properties of the same laminates produced with boron-free E glass reinforcement in anticipation of improved radiation resistance of this variant.

26162 (NBSIR—80-1627, pp 367-377) **Temperature dependence of Young's modulus and internal friction of G-10CR and G-11CR epoxy resins.** Ledbetter, H.M.; Maerz, G. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

The Young's moduli of the epoxy-resin matrix material used in NEMA-designation G-10CR and G-11CR fiberglass-cloth-reinforced composites were measured dynamically and semicontinuously between ambient and liquid-nitrogen temperatures. Both materials exhibit regular temperature behavior, showing large Young's-modulus changes, about 125 and 50%, respectively. Internal friction decreased about 80% during cooling to liquid-nitrogen temperature (76°K). The different thermoelastic coefficients of the two materials indicate a different internal structure.

26163 (NBSIR—80-1627, pp 379-393) **Directional variation of Young's modulus and internal friction in two fiberglass-cloth-epoxy composites.** Ledbetter, H.M. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Young's modulus was measured dynamically (near 50 kHz) for various directions in the warp-fill plane and in the warp-normal plane of laminated fiberglass-cloth-epoxy composites. Results are interpreted using an anisotropic elasticity model. Directional dependence of internal friction was determined on the same specimens. Directions of high modulus are directions of low internal friction, and vice versa.

26164 (NBSIR—80-1627, pp 395-404) **Thermal conductivity of G-10CR and G-11CR industrial laminates at low temperatures. Part II.** Hust, J.G. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Experimental thermal conductivity results are reported for G-10CR composite specimens from two suppliers and at strains up to 90% of ultimate at temperatures from 2 to 300°K. The results indicate considerable differences between the two manufacturers but essentially no effect due to strain. Data are also reported on the resins used in G-10CR and G-11CR. These results are difficult to understand and further measurements are scheduled to define their properties more clearly.

26165 (NBSIR—80-1627, pp 405-412) **Thermal expansion of cryogenic-grade glass-epoxy laminates.** Ranney, M.A.; Clark, A.F. (National Bureau of Standards, Boulder, CO). Jun 1980.

In Materials studies for magnetic fusion energy applications at low temperatures. III.

Thermal expansion measurements for special grades of NEMA-type G-10 and G-11 glass-epoxy laminates were carried out in a quartz-tube dilatometer over a temperature range 4 to 300°K. It was found that expansions in the warp direction were comparable to those of the samples' reinforcement fabric, whereas expansions in the normal direction were characteristic of the samples' epoxy resins.

POLYMERS AND PLASTICS

MECHANICAL PROPERTIES

26166 (MHSMP—80-15) **Toluene swelling of compressed Y-3223 cellular silicone cushions.** Myers, J.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1980. Contract AC04-76DP00487. 10p. NTIS, PC A02/MF A01.

Y-3223 cellular silicone cushions under a significant load and high temperature will take large compression sets and retain little of their resilience. To determine whether the compression set was of a chemical or mechanical nature, a toluene swell was performed on eight Y-3223 cushions which had previously been subjected to compressive forces under high temperatures. Load deflection tests were run before and after the swell. Comparisons between the load deflection tests revealed no recovery of the cushions. This indicated the nature of the problem was more chemical than mechanical.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 25769

DEGRADATION AND EROSION

REFER ALSO TO CITATION(S) 25769, 25792

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 25562, 25564, 25566, 25567, 25570, 25571, 25576, 25579, 25580, 25581, 25598, 26174

26167 (BDX—613-2415) **Density separation of boron particles. Final report.** Smith, R.M. (Bendix Corp., Kansas City, MO (USA)). Apr 1980. Contract AC04-76DP00613. 31p. NTIS, PC A03/MF A01.

A density distribution much broader than expected was observed in lots of natural boron powder supplied by two different sources. The material in both lots was found to have a rhombohedral crystal structure, and the only other parameters which seemed to account for such a distribution were impurities within the crystal structure and varying isotopic ratios. A separation technique was established to isolate boron particles in narrow density ranges. The isolated fractions were subsequently analyzed for B^{10} and total boron content in an effort to determine whether selective isotopic enrichment and nonhomogeneous impurity distribution were the causes for the broad density distribution of the boron powders. It was found that although the B^{10} content remained nearly constant around 18%, the total boron content varied from 37.5 to 98.7%. One of the lots also was found to contain an apparently high level of alpha rhombohedral boron which broadened the density distribution considerably. During this work, a capability for removing boron particles containing gross amounts of impurities and, thereby, improving the overall purity of the remaining material was developed. In addition, the separation technique used in this study apparently isolated particles with alpha and beta rhombohedral crystal structures, although the only supporting evidence is density data.

26168 **Graphite having improved thermal stress resistance and method of preparation.** Kennedy, C.R. (to Dept. of Energy). US Patent 4,190,637. 26 Feb 1980. Filed date 18 Jul 1978. 8p.

PAT-APPL-925,721.

An improved method for fabricating a graphite article comprises the steps of impregnating a coke article by first heating the coke article in contact with a thermoplastic pitch at a temperature within the range of 250 to 300°C at a pressure within the range of 200 to 2000 psig for at least 4 to 10 h and then heating at a temperature within the range of 450 to 485°C at a pressure of 200 to 2000 psig for about 16 to 24 h to provide an impregnated article; heating the impregnated article for sufficient time to carbonize the impregnant to provide a second coke article, and graphitizing the second coke article. A graphite having improved thermal stress resistance results when the coke to be impregnated contains 1 to 3 wt % sulfur and no added puffing inhibitors. An additional improvement in thermal stress resistance is achieved when the second coke article is heated above about 1400°C at a rate of at least 10°C/minute to a temperature above the puffing temperature.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 26167

PROPERTIES

REFER ALSO TO CITATION(S) 25562, 25571, 26626

26169 (ORNL—5648) **Cesium diffusion in graphite.** Evans, R.B. III; Davis, W. Jr.; Sutton, A.L. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 137p. NTIS, PC A07/MF A01.

Experiments on diffusion of ^{137}Cs in five types of graphite were performed. The document provides a completion of the report that was started and includes a presentation of all of the diffusion data, previously unpublished. Except for data on mass transfer of ^{137}Cs in the Hawker-Siddeley graphite, analyses of experimental results were initiated but not completed. The mass transfer process of cesium in HS-1-1 graphite at 600 to 1000°C in a helium atmosphere is essentially pure diffusion wherein values of (E/ϵ) and ΔE of the equation $D/\epsilon = (D/\epsilon)_0 \exp[-\Delta E/RT]$ are about 4×10^{-2} cm²/s and 30 kcal/mole, respectively.

26170 (UCRL—84399) **properties of low-index laser materials.** Weber, M.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 May 1980. Contract W-7405-ENG-48. 7p. (CONF-800552—1). NTIS, PC A02/MF A01.

From Topical conference on basic optical properties of materials; Gaithersburg, MD, USA (5 May 1980).

Measurements of n_2 for a large class of oxide and fluoride crystals and glasses have been made using 100-ps, 1.06-μm laser pulses and time-resolved interferometry. Values of n_2 for various glasses are summarized.

26171 **Neutron diffuse scattering in magnetite due to molecular polarons.** Yamada, Y.; Wakabayashi, N.; Nicklow, R.M. (Department of Physics, College of General Education, Osaka University, Toyonaka Osaka, Japan). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4642-4648(15 May 1980).

A detailed neutron diffuse scattering study has been carried out in order to verify a model which describes the property of valence fluctuations in magnetite above T/sub V/. This model assumes the existence of a complex which is composed of two excess electrons and a local displacement mode of oxygens within the fcc primitive cell. The complex is called a molecular polaron. It is assumed that at sufficiently high temperatures there is a random distribution of molecular polarons, which are fluctuating independently by making hopping motions through the crystal or by dissociating into smaller polarons. The lifetime of each molecular polaron is assumed to be long enough to induce an instantaneous strain field around it. Based on this model, the neutron diffuse scattering cross section due to randomly distributed dressed molecular polarons has been calculated. A precise measurement of the quasielastic scattering of neutrons has been carried out at 150 K. The observed results definitely show the characteristics which are predicted by the model calculation and, thus, give evidence for the existence of the proposed molecular polarons. From this standpoint, the Verwey transition of magnetite may be viewed as the cooperative ordering process of dressed molecular polarons. Possible extensions of the model to describe the ordering and the dynamical behavior of the molecular polarons are discussed.

26172 **Neutron scattering studies of $(CN)^-$ defects in KBr.** Rowe, J.M.; Rush, J.J.; Shapiro, S.M.; Hinks, D.G.; Susman, S. (National Measurement Laboratory, National Bureau of Standards, Washington, D.C. 20234). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4863-4868(15 May 1980).

We have studied both the librational and the tunneling excitations of $(CN)^-$ ions in a KBr matrix through the interaction of these modes with the acoustic phonons of the KBr host. From our measurements on a sample containing 0.00034 mole fraction of KCN in KBr, we find that A/sub 1g/-T/sub 2g/ tunnel splitting to be 0.28 +- 0.05 meV (2.3 +- 0.4 cm^{-1}). From measurements on a more concentrated system, 0.0045 mole fraction of KCN in KBr, the A/sub 1g/-E/sub g/ librational excitation energy is found to be 1.6 +- 0.1 meV (13.0 +- 1.0 cm^{-1}). These values are consistent with the results of optical measurements.

26173 **Spectroscopy of Cr^{3+} in glasses: Fano antiresonances and vibronic "Lamb shift".** Lempicki, A.; Andrews, L.; Nettel, S.J.; McCollum, B.C.; Solomon, E.I. (GTE Laboratories, Waltham, Mas-

sachusetts 02154). ER-78-C-02-4996.A000. *Phys. Rev. Lett.;* **44**: No. 18, 1234-1237(5 May 1980).

Absorption spectra of Cr^{3+}-doped glasses exhibit features which are interpreted as Fano antiresonances resulting from interaction of ^2E and $^2T_1$ states with a vibrationally broadened $^4T_2$. Inhomogeneous line broadening in glass permits the observation of a shift of sharp levels due to interaction with the quasicontinuum.

26174 Method of preparing a thermoluminescent phosphor. Lasky, J.B.; Moran, P.R. (to Dept. of Energy). US Patent 4,173,660. 6 Nov 1979. Filed date 13 Jul 1978. 6p.
PAT-APPL-924,338.

A thermoluminescent phosphor consisting of LiF doped with boron and magnesium is produced by diffusion of boron into a conventional LiF phosphor doped with magnesium. Where the boron dpoant is made to penetrate only the outer layer of the phosphor, it can be used to detect shallowly penetrating radiation such as tritium beta rays in the presence of a background of more penetrating radiation.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 25376

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 25376, 26139

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 25366

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 25365, 26750

26175 (AD-A—077326/7) **Determination of the fluorine content of fluorochemical-treated fabrics by neutron activation using the 19F(n,2n)18F reaction.** Johnson, F.A. (Defence Research Establishment, Ottawa, Ontario (Canada)). Oct 1979. 39p. NTIS, PC A03/MF A01.

An analytical procedure has been developed for determining the fluorine content of fluorochemical-treated fabrics by activation with fast neutrons, using Teflon film as the reference standard. The ultimate success of the technique depends on effective retention of the active recoil F18 nuclei produced in the F19(n,2n) F18 reaction, which is accomplished by sealing all samples individually in Mylar film. It is demonstrated that recoil protons produced in the fabric substrate by the incident neutrons create a measurable amount of F18 in the basic unfinished fabric through the O18(p,n) F18 reaction. The production of such excess F18 tends to compensate for systematic deficiencies encountered in the measurement of the total F18-activity of the finished fabric. It is shown that non-uniform activation of the irradiated samples due to the fall-off in neutron flux near the target could be overcome by use of a rotating and reciprocating sample holder.

26176 (DP—1527) **Trace elements retained in washed nuclear fuel reprocessing solvents.** Gray, L.W.; MacMurdo, K.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Sep 1979. Contract EY-76-C-09-0001. 21p. Dep. NTIS, PC A02/MF A01.

Analysis of purified TBP extractant from solvent extraction processes at Savannah River Plant showed several stable elements and several long-lived radioisotopes. Stable elements Al, Na, Br, Ce, Hg, and Sm are found in trace quantities in the solvent. The only stable metallic element consistently found in the solvent was Al, with a concentration which varies from about 30 ppM to about 10 ppM. The halogens Br and Cl appear to be found in the solvent systems as organo halides. Radionuclides found were principally ^{106}Ru, ^{129}I, ^{3}H, ^{235}U, and ^{239}Pu. The ^{129}I concentration was about 1 ppM in the first solvent extraction cycle of each facility. In the other cycles, ^{129}I concentration varied from about 0.1 to 0.5 ppM. Both ^{129}I and ^{3}H appear to be in the organic solvent as a result of exchange with hydrogen.

26177 (UCRL—80286(Rev.1)) **Consistent set of nuclear parameters values for absolute INAA.** Heft, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 25p. (CONF-800477—1). NTIS, PC A02/MF A01.

From American Nuclear Society topical conference; Mayagues, Puerto Rico (30 Apr 1980).

Gamma spectral analysis of irradiated material can be used to determine absolute disintegration rates for specific radionuclides. These data, together with measured values for the thermal and epithermal neutron fluxes, and irradiation, cooling and counting time values, are all the experimental information required to do absolute Instrumental Neutron Activation Analysis. The calculations required to go from product photon emission rate to target nuclide amount depend upon values used for the thermal neutron capture cross-section, the resonance absorption integral, the half-life and photon branching ratios. Values for these parameters were determined by irradiating and analyzing a series of elemental standards. The results of these measurements were combined with values reported by other workers to arrive at a set of recommended values for the constants. Values for 114 nuclides are listed.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 25212

26178 (MHSMP—80-23) **Analysis of fluoride in polymer materials.** Richardson, B.R. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). May 1980. Contract AC04-76DP00487. 12p. NTIS, PC A02/MF A01.

In order to determine whether bis (2,2-dinitro-2-fluorethyl) formal (FEFO) is present in polymers (silastic), a fluoride-specific ion electrode was tested. Interference was eliminated by means of matrix matching. The method was calibrated. 6 figures, 2 tables. (DLC)

26179 (MLM—2721) **Automated multi-sample gas chromatographic analysis of fossil fuel gases.** Rohler, D.R.; Young, G.L.; Franchetti, V.M. (Mound Facility, Miamisburg, OH (USA)). 11 Jun 1980. Contract AC04-76DP00053. 21p. NTIS, PC A02/MF A01.

Fully automated gas chromatographic analysis of multiple Fischer Assay retort gas samples has been achieved. The system used includes a commercially available microprocessor-controlled gas chromatograph fitted with an in-house-designed and constructed automated gas sampling rack. This system allows unattended duplicate analysis of four samples and one standard; the total output of analyses per day is twice that using manual operation. Automation of the rack is achieved through microprocessor control of four time-programmable contact closures which operate a set of valves and a printer for sampling, regulating, and recording manifold pressure. Accuracies and precisions using the gas chromatograph sampling rack automatically are comparable to those achieved during manual operation.

26180 (UCRL—83153(Rev.1)) **Precipitation titration of perchlorate using new titrants.** Selig, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 10p. NTIS, PC A02/MF A01.

We have evaluated the following new titrants for the potentiometric precipitation titration of perchlorate: cetyltrimethylammonium chloride (CETAC), cetyltrimethylammonium bromide (CETAB), cetylpyridinium chloride (CPC), and benzyldimethyltetradecylammonium chloride (BDTAC). Titrations were monitored with a fluoroborate ion-selective electrode (ISE) and a double-junction reference electrode. The titration system was controlled by a Tektronix 4051 graphics system. The perchlorate, nitrate, and calcium ISE may also be used to monitor emf's. 7 tables, 2 figures.

26181 (UCRL—84351) **Analytical testing and characterization of three polysiloxane gums.** Kolb, J.R.; Cady, W.E.; Jessop, E.S.; Hoffman, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Apr 1980. Contract W-7405-ENG-48. 19p. (CONF-800628—1). NTIS, PC A02/MF A01.

From JOWOG-28 conference; Kansas City, MO, USA (16 Jun 1980).

Because of the termination of both silicone gums and cellular silicone products by Union Carbide Corporation, it has been necessary to evaluate commercial alternatives as well as potential developmental polymer replacements for W97. For this reason, LLNL, Bendix Corporation, and the Pantex plant have undertaken the development of characterization methodology for silicone gums as well as the concomitant chemical and physical analyses of the polysiloxanes RG97, SE54 and Y3976. The most viable test battery to arise from this study is the determination of anti M/sub w/, anti M/sub n/, and MWD by GPC, vinyl and phenyl contents of the gums by magnetic resonance or chromatographic techniques, and volatile content of the gums by thermogravimetric analysis. A comparison of the siloxane gums indicates that the random SE54 is a high phenyl content, high molecular weight, low volatile resin of high quality. RG97 is in contrast a relatively low molecular weight, high volatile content gum that is inferior to SE54. The developmental material Y3976, which is synthesized by a different procedure, is close in properties to the SE54 gum but is somewhat lower in phenyl content. 3 figures, 10 tables.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 25433, 25440, 25442, 26176

26182 (LA-UR—80-1274) **Application of linear accelerator technology to the detection of trace amounts of transuranics in waste barrels.** Cates, M.R.; Noel, B.W.; Caldwell, J.T.; Kunz, W.E.; Close, D.A.; Franks, L.A.; Pigg, J.L. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 24p. (CONF-800611—3). NTIS, PC A02/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

Electron linear accelerators (linacs), as sources of photons and neutrons, can produce a significant number of fissions in transuranic isotopes contained in large barrels of waste material. Both photons and thermal neutrons have been used to detect about 1 mg of plutonium in 105-kg matrices. A sequential interrogation with neutrons and photons, easily possible with linacs, can show both fertile and fissile constituents among the heavy-mass isotopes. The advantages of linacs in solving existing assay problems include: (1) high available beam current; (2) variable beam current, beam energy, pulse width, and pulse repetition frequency; and (3) beam-scanning ability. They also are compatible with passive assay instruments. Their versatility makes it likely that they will remain useful as assay technology advances.

26183 (ORNL/TM—7051) **BGSUB and BGFIX: FORTRAN programs to correct Ge(Li) gamma-ray spectra for photopeaks from radionuclides in background.** Cutshall, N.H.; Larsen, I.L. (Oak Ridge National Lab., TN (USA)). Mar 1980. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

Two FORTRAN programs which provide correction and error analysis for background photopeak contributions to low-level gamma-ray spectra are discussed. A peak-by-peak background subtraction approach is used instead of channel-by-channel correction. The accuracy of corrected results near background levels is substantially improved over uncorrected values.

26184 (PNL-TR—382) **Use of the VRA 2 x-ray spectrometer with KSR 4100 small control computer in the structural glass industry for glass and raw material analysis.** Medicus, G. Translated from *Silikattechnik;* **29**: No. 7, 208-210(1978). 18p. NTIS, PC A02/MF A01.

The positive experiences with the KSR 4100 small control computer on the VRA 2 x-ray fluorescence spectrometer show that x-ray spectrometers should fundamentally be operated with directly coupled evaluation computers. The use of the computer not only provides advantages by shortening the access time for analytical results and by reduction of personnel because of the absence of manual evaluation, but the possibilities of a more rapid calibration for new test materials should also be emphasized. For analytical procedures in which matrix effects are to be found, suitable calibration equations can be found with the help of regression calculation. If the KSR 4100 is used in the variation with the maximum obtainable memory, 16 K, it should be possible in principle to run regression programs, although the relatively slow output through the coupled teletype printer is quite troublesome. External larger computer units are considered to be optimal for extensive regression calculations for the calibration of the VRA 2 KSR 4100 instrument complex.

26185 (UCRL—50400(Vol.22)) **GAMIDENT: a program to aid in the identification of unknown materials by gamma-ray spectroscopy.** Howerton, R.J.; Eggens, C.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1980. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

A computer code, called GAMIDENT, was written to help identify isotopes by their gamma-ray emissions and thus to assist in the non-destructive assay of unknown materials. The program searches a file (called GAMIN) of gamma-ray spectra, from both radioactive decays and neutron captures, for matches with observed photon energies. This report describes the search procedure used, outlines the use of the code, and gives examples. The code is designed for operation at the Lawrence Livermore Laboratory on a CDC-7600 computer. It is written in standard Fortran (ANSI) as much as possible, but it contains some LRLTRAN instructions required to make use of the Livermore Timesharing System. The code uses about 30,000 words of SCM and about 550,000 words of LCM. Typical problems run in less than 30 seconds. The source program and the data file are available on request.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 26437

26186 (Y/DK—254) **Determination of mercury in rocks, sediments, and soils by flameless atomic absorption.** White, L.E.; Carter, M.H. Jr. (Oak Ridge Y-12 Plant, TN (USA)). 22 May 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

A simple, relatively fast method for the determination of mercury in rocks, sediments, and soils has been developed to meet the needs of the National Uranium Resources Evaluation Project. One gram of the less than 100 mesh material is placed in a 250-mL reagent bottle and is digested using a mixture of concentrated sulfuric acid and 30% hydrogen peroxide. To prevent the loss of mercury during the digestion procedure, an 18-inch dry reflux tower is employed. After digestion, the sample is treated with 5% potassium permanganate solution, and a sodium chloride-hydroxylamine sulfate reagent. Tin (11) sulfate is then added and the sample immediately attached to an aeration device. The volatilized mercury is swept into an absorption cell by an argon stream and is measured by an atomic absorption spectrophotometer adjusted to 253.7 nanometer wave-length. Absorption is then plotted by a strip chart recorder.

26187 **Interfacing a diamond anvil cell with a commerical interferometer.** Ferraro, J.R.; Basile, L.J. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Appl. Spectrosc.;* **34**: No. 2, 217-219(Mar 1980).

A 6X Harrick beam condenser was interfaced with the DAC in a 20A interferometer. The system was used to measure the infrared spectra of $SnCl_2$ and Ag_2I_4.(AIP)

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 25382

26188 (BM-IC—8818) **Physical chemistry of mineral-reagent interactions in sulfide flotation.** Richardson, P.E.; Hyde, G.R.; Ojalvo, M.S. (comps.). (Bureau of Mines, Washington, DC (USA)). 1980. 171p. (CONF-7804172—). GPO.

From Symposium on the physical chemistry of mineral-reagnet interactions in sulfide flotation; College Park, MD, USA (6 Apr 1978).

This symposium was sponsored by the Bureau of Mines, US Department of the Interior, in order to critically examine the state-of-the-art of sulfide flotation chemistry and to define current and emerging problems that should be emphasized in future fundamental research. The topics covered through invited papers include both reviews and recent research results in the areas of thermodynamics of reagent-mineral interactions; collector adsorption processes; the effects of solid-state point defects on flotation; activation and deactivation phenomena; the electrochemical role of oxygen in sulfide flotation; environmental problems in flotation; and selective flocculation of fines. Papers giving perspectives on flotation research in relationship to our national mineral requirements and the relationships between industrial flotation research and academics are also presented. An edited summary of the symposium follows the ten papers.

26189 (ORNL/MIT—301) **Distribution ratios on Dowex 50W resins of metal leached in the caron nickel recovery process.** Reynolds, B.A.; Metsa, J.C.; Mullins, M.E. (Massachusetts Inst. of Tech., Oak Ridge, TN (USA). School of Chemical Engineering Practice). May 1980. Contract W-7405-ENG-26. 25p. NTIS, PC A02/MF A01.

Pressurized ion exchange on Dowex 50W-X8 and 50W-X12 resins was investigated using elution techniques to determine distribution ratios for copper, nickel, and cobalt complexes contained in ammonium carbonate solution, a mixture which approximates the waste liquor from the Caron nickel recovery process. Results were determined for different feed concentrations, as well as for different concentrations and pH values of the ammonium carbonate eluant. Distribution ratios were compared with those previously obtained from a continuous annular chromatographic system. Separation of copper and nickel was not conclusively observed at any of the conditions examined.

26190 (ORNL/TM—6738) **Computer simulation of displacement cation exchange chromatography: separation of trivalent actinides and lanthanides.** Forsberg, C.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 84p. NTIS, PC A05/MF A01.

A first-generation mathematical model of displacement cation exchange chromatography (CES) was constructed. The model incorporated the following phenomena: diffusion of cations up and down the column, diffusion of cations from the bulk liquid to the resin surface, and equilibrium of cations between liquid and solid resin beads. A limited number of experiments with rare earths using DTPA as the separation agent were undertaken to increase the current understanding of the processes involved in cation exchange chromatography. The numerical computer program based on the mathematical model was written in FORTRAN IV for use on the IBM 360 series of computers.

26191 (DP-TR—7) **Separation and quantitative analysis of krypton and xenon by gas chromatography: application to fission gas.**

Aubeau, R.; Champeix, I.; Reiss, J. Translated from *J. Chromatogr.*; 6: 209-219(1961). 12p. NTIS, PC A02/MF A01.

Gas chromatography in a column consisting of a 5 angstrom molecular sieve fitted with a thermal conductivity detector allows the quantitative analysis of the total amount of krypton and xenon, active or inactive, extracted from irradiated fuel elements, with a desired sensitivity. Analysis of a specimen of gas containing fission gas (krypton and xenon) alone or mixed with other gases (H_2-O_2-A-N_2-CO) was carried out at a temperature of 100°C. In a single procedure, all these elements were separated and detected with high sensitivity. If the specimen is large (volume greater than 200 mm^3), or if methane is present (very unusual case, apparently), 50°C would be used, resulting in lower sensitivity. The sensitivity of this method can surely be improved. Some minimum quantities of 0.2 mm^3 of krypton and 0.5 mm^3 of xenon, however, can still be measured now.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 25177, 25328, 25448, 26284

26192 (BNL—27523) **Lattice expansion as a measure of surface segregation and solubility of hydrogen in α-FeTiH/sub x/.** Reilly, J.J.; Johnson, J.R.; Reidinger, F.; Lynch, J.F.; Tanaka, J.; Wiswall, R.H. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 19p. (CONF-800402—12). NTIS, PC A02/MF A01.

From International symposium on the properties and applications of metal hydrides; Colorado Springs, CO, USA (7 Apr 1980).

The lattice expansion of α-FeTiH/sub x/ was found to be anomalously small as a function of hydrogen content. The apparent partial molar volume of hydrogen, anti V/sub H/, was 0.1 +- 0.1 cc/g atom (FeTiH/sub <0.03/), a value much lower than the accepted range of 2.2 to 1.4 cc/g atom previously reported for hydrogen-metal solutions. The behavior is attributed to preferential occupation by hydrogen of Ti rich sites produced by surface segregation effects which are known to occur in activated FeTi. The α/α + β phase boundary is estimated to occur at an overall composition equivalent to FeTi/sub ~ 0.04/. At this composition ~ 85% of the total hydrogen content is estimated to be associated with surface layers ~ 100 A in depth. Unactivated FeTi (low surface area) behaved quite differently and it is clear that in the low dilution region surface segregation effects play a dominant role with respect to system behavior. Evidence is also presented that strain and dislocations produced by a hydriding-dehydriding cycle increase hydrogen solubility and shift the phase boundary towards higher hydrogen contents.

26193 (BNL—27677) **Formalisms for electron exchange kinetics in aqueous solution, and the role of ab initio techniques in their implementation.** Newton, M.D. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 58p. (CONF-800369—1). NTIS, PC A04/MF A01.

From International symposium on atomic, molecular, and solid-state theory; Flagler Beach, FL, USA (10 Mar 1980).

Formalisms suitable for calculating the rate of electron exchange between transition metal complexes in aqueous solution are reviewed and implemented in conjunction with ab initio quantum chemical calculations which provide crucial off-diagonal Hamiltonian matrix elements as well as other relevant electronic structural data. Rate constants and activation parameters are calculated for the hex-aquo Fe^{2+}-Fe^{3+} system, using a simple activated complex theory, a non-adiabatic semi-classical model which includes nuclear tunnelling, and a more detailed quantum mechanical method based on the Golden Rule. Comparisons are made between calculated results and those obtained by extrapolating experimental data to zero ionic strength. All methods yield similar values for the overall rate constant (~ 0.1 L/(mol-s)). The experimental activation parameters (ΔH^{++} and ΔS^{++}) are in somewhat better agreement with the semi classical and quantum mechanical results than with those from the simple activated complex theory, thereby providing some indication that non-adiabaticity and nuclear tunnelling may be important in the Fe/sup 2+/3+/ exchange reaction. It is concluded that a model based on direct metal-metal overlap can account for the observed reaction kinetics provided the reactants are allowed to approach well within the traditional contact distance of 6.9 A. 6 figures, 7 tables.

26194 (CONF-800630—1) **Classical ionic fluids in the mean spherical approximation.** Triolo, R.; Floriano, A.M. (Oak Ridge National Lab., TN (USA); Palermo Univ. (Italy). Ist. di Chimica Fisica; Alberta Univ., Edmonton (Canada). Dept. of Chemistry). 1980. Contract W-7405-ENG-26. 47p. NTIS, PC A03/MF A01.

From 5. international symposium on solute-solvent interactions; Florence, Italy (2 Jun 1980).

The recently obtained analytical solution of the mean spherical approximation (MSA) has been used to calculate thermodynamic and structural properties of aqueous solutions of symmetric as well as of asymmetric electrolytes. The same approximation has been also used to calculate structure functions of pure and mixed molten salts. The agreement between experimental or quasi-experimental structure functions and those obtained within the framework of the MSA is quite good especially when the ionic radii are obtained by fitting the long wavelength limit of the structure functions to the isothermal compressibility of the system, while the diameter ratio is the same as in the crystal.

26195 (DOE/ER/10443—1) **High pressure studies to determine the effects of volume and temperature on the lattice dynamics of molecular solids: N_2, CO_2, CH_4. Progress report for period July 1, 1979 - June 30, 1980.** Medina, F.D. (Northeastern Univ., Boston, MA (USA)). May 1980. Contract AC02-79ER10443. 7p. NTIS, PC A02/MF A01.

The temperature dependence of the far infrared spectrum of α-N_2 was studied for a sample at constant volume. The two modes observed near 50 and 72 cm^{-1} have frequencies which increase slightly with temperature. The integrated intensity of the mode near 50 cm^{-1} remains constant with temperature, within experimental uncertainty. The Grueneisen parameter of this mode was estimated to be ~ 3. A study of the volume dependence of the infrared spectrum of α-N_2 is currently under progress. Two samples of solid CH_4 of different densities were grown. Grueneisen parameters of 2.6 and 3.1 were obtained for the librational mode and one translational mode in phase II. The former indicates an anisotropic intermolecular potential with a strong volume dependence. Changes in the spectrum indicate that the II-III phase transition involves a sudden, simultaneous tetragonal distortion of the lattice and ordering of the orientationally disordered molecules of phase II, with a slow reorientation of the ordered molecules. The librational mode of phase II does not go soft near the transition to the orientationally disordered phase I. The temperature dependence of the linewidth for this mode can be explained by a thermally activated reorientation of the ordered molecules in phase II with an activation energy of 60 cm^{-1}.

26196 (DOE/ER/10458—1) **Vibrational energy transfer kinetics in molecular disequilibrium. Status report.** Rich, J.W. (Calspan Corp., Buffalo, NY (USA)). Mar 1980. Contract AC02-79ER10458. 13p. NTIS, PC A02/MF A01.

A c-w CO laser was used to excite the CO vibrational mode in mixtures of CO and various other gases (N_2, Ar, NO). Products are $(CN)_2$ and C_2. Two possible mechanisms for C_2 formation are discussed. 3 figures, 3 tables. (DLC)

26197 (DOE/ER/10485—1) **Studies of supported metal catalysts. Progress report, September 1, 1979-August 31, 1980.** Hercules, D.M. (Pittsburgh Univ., PA (USA)). May 1980. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01.

Research was carried out on four separate catalyst systems: Co-Al_2O_3; Mo-Al_2O_3; Co/Mo/Al_2O_3; and Ni. Work was completed on the interactions between cobalt and γ-Al_2O_3. Work was begun on the combined Co/Mo/Al_2O_3 system. A separate study is in progress on support interactions between nickel and a variety of supports; particular emphasis has been on the effect of preparation method.

26198 (DOE/FE/13547—01) **Thermochemical stability diagrams for condensed phases and volatility diagrams for volatile species over condensed phases in twenty metal-sulfur-oxygen systems between 1150 and 1450°K.** Gulbransen, E.A.; Meier, G.H. (Pittsburgh Univ., PA (USA). Dept. of Metallurgical and Materials Engineering). May 1980. Contract AC01-79ET13547. 222p. NTIS, PC A10/MF A01.

This work begins with a description of the thermochemistry of gaseous species in the H-O-S-C system and the role of condensed and volatile species in oxidation and hot corrosion phenomena. The major part of the report is a description of the stability diagrams and diagrams for the volatile metal oxide and sulfide species in the A1-O-S, Ca-O-S, Ce-O-S, Co-O-S, Cr-O-S, Fe-O-S, Hf-O-S, K-O-S, Mg-O-S, Mn-O-S, Mo-O-S, Na-O-S, Ni-O-S, Nb-O-S, Si-O-S, Ta-O-S, Ti-O-S, V-O-S, W-O-S, and Zr-O-S systems. Log p/ sub O_2/ vs log p/ sub S_2/ diagrams are developed to show the stability regions for the several metal, oxide, sulfide and sulfate phases for four temperatures 1150, 1250, 1342, and 1450°K. Log p/sub M//sub x//sub O///sub y/ vs log p/sub O_2/ and log p/sub M//sub x//sub S//sub y/ vs log p/sub S_2/ are developed for twenty oxide and sulfide systems at 1250°K. Log p/sub M//sub x//sub O//sub y/ vs 1/T and log p/sub M//sub x//sub S//sub y/ vs 1/T diagrams are developed to summarize the results. Here log p/sub M//sub x//sub O//sub y/ and log p/sub M//sub x//sub S//sub y/ refer to the several metal, oxide and sulfide vapor species. The importance of the volatile species, melting points of the condensed phases and constitution of the condensed phases as a function of the oxygen and sulfur potential of the reaction environment is discussed with regard to high temperature oxidation and hot corrosion of metals and alloys.

26199 (LBL—10545) **Crossed molecular beam studies of chemiluminescent reactions.** Kahler, C.C. (California Univ., Berkeley

(USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 175p. NTIS, PC A08/MF A01.

Thesis.

The chemiluminescent bimolecular halogen-halogen reactions of F_2 with I_2, Br_2, and ICl, were studied by the crossed molecular beam technique. The observed reaction thresholds of 4.2 and 5.9 kcal/mole for $I_2 + F_2$ and $ICl + F_2$, respectively, are the same as the threshold energies for production of the stable trihalogens I_2F and ClIF. A threshold of 11.3 kcal/mole was found for $Br_2 + F_2$; no threshold for Br_2F has been previously reported. Also described is a crossed molecular beam study of the chemiluminescent reaction of $NO + O_3 \rightarrow NO_2^* + O_2$. The cross section was found to increase with increasing collision energy. The reaction threshold was 2.1 kcal/mole. The chemiluminescence was found to increase with increasing NO temperature. This can be explained by assuming the cross section varies as E/sub rot//sup 1.4/ where E/sub rot/ is the average rotational energy of the NO beam. The chemiluminescence enhancement did not have the dependence on the increased NO(^{2}PI/sub 3/2/) population as suggested. The emission curve shifted to the blue as the collision energy increased.

26200 (LBL—10767) **State-of-the-art review of phase equilibria.** Prausnitz, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 55p. (CONF-800368—1). NTIS, PC A04/MF A01.

From 2. international conference on phase equilibria and fluid properties in the chemical industry; Berlin, F.R. Germany (17 Mar 1980).

High-pressure phase-equilibrium calculations using an equation of state are more sensitive to the mixing rules than to details in the effect of density or temperature on pressure. Attention must be given to the problem of how to extend equations of state to mixtures. One possible technique is provided by perturbation theory; another by superposition of chemical equilibria. At low or moderate pressures, vapor-phase corrections are often important. When specific intermolecular forces produce formation of molecular aggregates, strong deviations from ideal-gas behavior can be significant even at pressures well below 1 bar. When vapor-liquid equilibrium data are reduced using conventional expressions for the excess Gibbs energy, the resulting binary parameters tend to be partially correlated, it difficult, but no impossible, to calculate ternary liquid-liquid equilibria using binary parameters only. New models for calculating properties of liquid-phase mixtures mist allow for changes in free volume to give consideration to the effect of mixing on changes in rotational and vibrational degrees of freedom. Liquid-phase volumetric effects are also important in describing the solubilities of gases in solvent mixtures. Therefore, future liquid-phase models should incorporate a liquid-phase equation of state, either of the van der Waals type or, perhaps, as given by the direct-correlation function theory of liquids.

26201 (SAND—80-0308) **Simple method for the calculation and use of CVD phase diagrams with applications to the Ti-B-Cl-H system, 1200 to 800°K.** Randich, E.; Gerlach, T.M. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract EY-76-C-04-0789. 47p. NTIS, PC A03/MF A01.

A simple method for calculating multi-component gas-solid equilibrium phase diagrams for chemical vapor deposition (CVD) systems is presented. The method proceeds in three steps: dterminaton of stable solid assemblages, evaluation of gas-solid stability relations, and calcuation of conventional phase diagrams using a new free energy minimization technique. The phase diagrams can be used to determine (1) bulk compositions and phase fields accessible by CVD techniques; (2) expected condensed phases for various starting gas mixtures; and (3) maximum equilibrium yields for specific CVD process variables. The three step thermodynamic method is used to calcuate phase diagrams for the example CVD system Ti-B-Cl-H at 1200 and 800°K. Examples of applications of the diagrams for yield optimization and experimental accessibility studies are presented and discussed. Experimental verification of the TiB_2 + Gas/Gas phase field boundary at 1200°K, H/Cl = 1 confirms the calculated boundary and indicates that equilibrium is nearly and rapidly approached under laboratory conditions.

26202 (UCRL—15159) **Synthesis of block copolymers of methyl siloxane, phenyl siloxane, vinyl siloxane, etc.** Ibemesi, J.A.; Meier, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1979. Contract W-7405-ENG-48. 8p. NTIS, PC A02/MF A01.

Synthesis of homo poly(dimethylsiloxane) PDMS, homo poly(diphenylsiloxane PDPS, and di- and tri- block copolymers of PDMS and PDPS have been carried out by anionic living polymerization, using the following reagents: hexamethylcyclotrisiloxane, HMTS and hexaphenylcyclotrisiloxane, HPTS (monomers), n-BuLi and dilithium diphenyldisilanolate, DLS (initiators), DMSO and THF (promoters) and Toluene (solvent). Lithium based catalysts are used in order to minimize siloxane rearrangement (equilibration) reactions.

26203 **Delocalized two-electron three-center C-H-metal interaction. Single crystal neutron (30 and 110 K) and X-ray (298 K) diffraction study of $[Fe(P(OCH_3)_3)_3(eta^3\text{-}C_8H_{13})]^+[BF_4]^-$.** Brown, R.K. (Argonne National Lab., IL); Williams, J.M.; Schultz, A.J.; Stucky, G.D.; Ittel, S.D.; Harlow, R.L. *J. Am. Chem. Soc.;* **102**: No. 3, 981-987(30 Jan 1980).

The crystal and molecular structure of $[Fe(P(OCH_3)_3)_3(eta^3\text{-}C_8H_{13})][BF_4]$ has been determined at 298 K by x-ray diffraction and at 110 and 30 K by neutron diffraction techniques. The crystals belong to the monoclinic space group P2/sub 1//c [C/sub 2h/^{5};no. 14] with unit cell dimensions of a = 9.018 (2) A, b = 18.815 (4) A, c = 16.974 (2) A, β = 101.75 (1)°, and V = 2819.7 A^3 at 298 K; a = 8.947 (6) A, b = 18.508 (13) A, c = 16.594 (11) A, β = 101.71 (7)°, and V = 2690.7 A^3 at 110 K; and a = 8.936 (2) A, b = 18.401 (4) A, c = 16.515 (5) A, β = 101.75 (3)°, and V = 2658.7 A^3 at 30 K, with Z = 4. Full-matrix least-squares refinement of the x-ray data led to $R(F_0)$ = 0.046 and R/sub w/(F_0) = 0.043 for the 3701 reflections (368 variables) with $F_0 > 3\sigma(F_0)$. Full-matrix least-squares refinement of the neutron data led to $R(F_0^2)$ = 0.142 and $R(F_0)$ = 0.156 for all 3784 independent data at 110 K and to $R(F_0^2)$ = 0.077 and $R(F_0)$ = 0.075 for all 6354 independent data at 30 K. The most significant structural finding is the existence of a C-H ... Fe three-center interaction which contains a very short Fe...H distance of 1.874 (3) A at 30 K. The hydrogen occupies the sixth coordination site of a distorted octahedron about the otherwise formally 16-electron Fe atom, thus relieving the coordinative and electronic unsaturation of the cationic iron complex. An even more striking feature in this three-center interaction is the stretched aliphatic C-H bond, the longest ever observed in a crystal, with an internuclear separation of 1.164 (3) A. 38 references, 2 figures, 4 tables.

26204 **L_α-edge anomalous scattering of x-rays by praseodymium and samarium.** Templeton, L.K. (Univ. of California, Berkeley); Templeton, D.H.; Phizackerley, R.P. Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **102**: No. 3, 1185-1186(30 Jan 1980).

Measurements are reported for the anomalous scattering of x-rays by atoms of praseodymium and samarium at wavelengths through their L_α absorption edges. Values of both f' and f'', the real and imaginary components of the anomalous scattering, were derived from diffraction experiments using synchrotron radiation. Both components exhibit exceptionally large changes in a narrow interval of wavelength, changes which offer a useful tool for solving the phase problem in crystal structure analysis. Crystals of sodium praseodymium ethylenediaminetetraacetate octahydrate and the isomorphorphous samarium, crystallize in the noncentric space group Fdd2. The atomic coordinates and thermal parameters were determined using Mo Kα radiation. The values found for the anomalous scattering terms are plotted, and listed, with the respective R values for each data set. For each data set, f' exhibits the striking resonance line which is observed in the absorption curves. 1 figure, 2 tables.

ISOTOPE EFFECTS

26205 (MLM—2729(OP)) **Hydrogen mobility at high concentrations.** Bowman, R.C. Jr. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 112p. NTIS, PC A06/MF A01.

The roles of crystal structure, hydrogen site occupancy, phase transition, and isotope substitution on the hydrogen diffusion behavior will be considered. After brief discussions of general diffusion concepts and the experimental methods that have been most often used to determine the hydrogen mobility in the high concentration metal hydride phases, the nuclear magnetic resonance techniques that have been extensively applied in hydride diffusion studies will be reviewed in some detail. The emphasis will be on relating measured nuclear relaxation times with diffusion parameters as well as NMR techniques to directly measure the hydrogen diffusion constants. The diversity of diffusion behavior will be illustrated with several specific metal hydride systems including PdH/sub x/, γ-TiH/sub x/ and structurally related TiCuH, and VH/sub x/. Plausible models of the microscopic diffusion mechanisms will also be presented and compared with the observed diffusion behavior in these systems.

26206 **Anomalies in the fractionation by chemical equilibrium of $^{18}O/^{16}O$ relative to $^{17}O/^{16}O$.** Skaron, S.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92717). *J. Chem. Phys.;* **72**: No. 12, 6810-6811(15 Jun 1980).

A theoretical investigation of relative $^{18}O.^{16}O$ and $^{17}O/^{16}O$ isotope effects is reported in order to test the geo-cosmochemical assumption that equilibrium processes lead to R values around 2. (AIP)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 25179, 25210, 26195, 26203, 26204, 26437

26207 (UCRL—15187) **Polynitroalkyltetrazoles.** Grakauskas, V.; Albert, A.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Mar 1980. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

5-(Fluorodinitromethyl)- and 5-(trinitromethyl)tetrazoles were synthesized in the reactions of fluorodinitroacetonitrile with sodium azide, and trinitroacetonitrile with trimethylsilyl azide, respectively, and characterized as their ammonium salts.

26208 Enzymatic synthesis and carbon-13 nuclear magnetic resonance conformational studies of disaccharides containing β-D-galactopyranosyl and β-D-[1-^{13}C]Galactopyranosyl residues. Nunez, H.A.; Barker, R. (Michigan State Univ., East Lansing). *Biochemistry;* **19**: No. 3, 489-495(5 Feb 1980).

Partially purified UDPgalactosyltransferase (EC 2.4.1.22) from bovine milk has been used to synthesize millimolar amounts of compounds such as Galβ(1→4)Glc, Galβ(1→4)GlcNAc-β-hexanolamine, and Galβ(1→4)-GlcNAcβ(1→4)GlcNAc. The same method has been used to prepare similar compounds containing ^{13}C-enriched galactopyranosyl moieties. Galβ(1→4)GlcNAc-β-hexanolamine was also synthesized in a solid-phase system in which the GlcNAc-β-hexanolamine glycoside was covalently linked to agarose beads. At pH 7.0 and at 1 to 5 mM Mn^{2+} the yields of the galactosyl saccharides are greater than 90% by using 10% excess of UDPGal donor. The use of a 90% enriched [1-^{13}C]galactosyl residue allowed the determination of the most abundant conformer about the galactopyranosyl-glycoside linkage by analysis of the carbon-carbon coupling constants from Cl to Gal to the C3′, C4′, and C5′ of GlcNAc or Glc. 3 figures, 1 table.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 26211, 26217

26209 (DOE/ER/03118—13) **Hydrogen-transfer and charge transfer in photochemical and high energy radiation induced reactions: effects of thiols. Final report, February 1, 1960-January 31, 1979.** Cohen, S.G. (Brandeis Univ., Waltham, MA (USA)). Mar 1980. Contract EY-76-S-02-3118. 19p. NTIS, PC A02/MF A01.

Absorption of ultraviolet or visible light, or high energy radiation, may lead to highly reactive free radicals. Thiols affect the reactions of these radicals in the following ways: (1) transfer of hydrogen from sulfur of the thiol to a substrate radical, converting the radical to a stable molecule, and the thiol to a reactive thiyl radical; and (2) transfer of hydrogen from a substrate radical or molecule to thiyl, regenerating thiol. The thiol is thus used repeatedly and a single molecule may affect the consequences of many quanta. Three effects may ensue, depending upon the system irradiated: (1) the substrate radicals may be converted by thiol-thiyl to the original molecules, and protection against radiation damage is afforded. (2) The radicals may be converted to molecules not identical with the starting materials, and in both cases damage caused by radical combination processes is prevented. (3) Product yields may be increased where the initial radicals might otherwise regenerate starting materials. It was shown that rates of reaction of excited species can be correlated with triplet energies and reduction potentials, and with ionization potentials, that amines are very reactive toward excited carbonyl compounds of all types, and that yields of products from these reactions can be increased by thiols, leading to increased efficiency in utilization of light.

26210 Infrared photochemistry of ethylene clusters. Casassa, M.P.; Bomse, D.S.; Beauchamp, J.L.; Janda, K.C. (Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasedaena, California 91125). DE-A503-76SF00767. *J. Chem. Phys.;* **72**: No. 12, 6805-6806(15 Jun 1980).

Infrared irradiation of ethylene clusters formed in supersonic molecular beams, using a low power cw CO_2 laser, results in the photodissociation of a large fraction of the van der Waals molecules. Under such conditions, infrared absorption intensity exhibits first-order power dependence and is readily detected as loss in molecular beam intensity. Intramolecular energy transfer rates, determined by measuring spectral linewidths, are shown to vary with the vibrational mode initially excited. Ethulene clsuters containing one quantum of vibrational energy corresponding to the ν_{7} fundamental in the monomer (949 cm^{-1}) have a vibrationally predissociative lifetime of 0.33 psec. In comparison, the relaxation rate of ethulene-d_4 clusters with one quantum of exctation corresponding to the ν_{12} (1078 cm^{-1}) mode of C_2D_4 is 0.7 psec.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 25203, 26209

26211 (NDRL—2123) **Radiation Laboratory quarterly report, January 1, 1980-March 31, 1980.** (Notre Dame Univ., IN (USA). Radiation Lab.). 1980. Contract AC02-76ER00038. 64p. NTIS, PC A04/MF A01.

Investigations in progress include: the dependence of specific rates for excess-electron scavenging in nonpolar liquids on election energy; optical response of trapped electrons; electron solvation in polar media and microscopic theory of dielectric relaxation; electron capture rates in gas phase; motion of slow electrons in polyatomic gases; electron thermalization in gases; electron distribution functions in gases; positron transport and decay in rare gases; Bragg curve spectroscopy and related topics in argon-methane mixtures; effect of reaction-produced spatial inhomogeneity on subsequent dynamics; symmetry in the long-range theory of intermolecular forces; dipole moments of photochemical transients; vibrational exciton interactions in catechol; laser-excited fluorescence in carbon disulfide; radiation chemistry studies with heavy ions; pulse radiolysis of Br^-; reactions of iron porphyrins with methyl radicals; oxidative c-c bond clevage by Ag^{2+}; pulse radiolytic study of Ni(II) iminodiacetates; liped damage by CCl_3 radical; photochemical properties of the β-diketonate complexes; and the photochemistry of copper (II) complexes with Schiff bases. Abstracts of reports published during the quarter are included.

26212 Pattern of addition of hydroxyl radicals to the spin traps α-pyridyl 1-oxide N-tert-butyl nitrone. Neta, P. (Univ. of Notre Dame, IN); Steenken, S.; Janzen, E.G.; Shetty, R.V. *J. Phys. Chem.;* **84**: No. 5, 532-534(6 Mar 1980).

Hydroxyl radicals react with α-2-, α-3, and α-4-pyridyl 1-oxide N-tert-butyl nitrones (POBN) with rate constants of 3.2 x 10^9, 4.8 x 10^9, and 3.5 x 10^9 M^{-1} s^{-1}, respectively, via addition to two distinct sites. Addition to the pyridine ring yields short-lived radicals of the hydrozyazacyclohexadienyl type, while addition to the nitrone function in the side chain yields long-lived nitroxide radicals. The distribution of OH addition at the two molecular sites was determined by using differences in reducing power upon reaction of the different types of radicals with $IrCl_6^{2-}$. The fraction of OH attack on the pyridine ring is ~ 0.6, relatively independent of the isomeric structure of the POBN.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 25444

26213 (RFP—2929) **Materials selection of surface coatings in an advanced size reduction facility.** Briggs, J.L.; Younger, A.F. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 2 Jun 1980. Contract AC04-76DP03533. 25p. NTIS, PC A02/MF A01.

A materials selection test program was conducted to characterize optimum interior surface coatings for an advanced size reduction facility. The equipment to be processed by this facility consists of stainless steel apparatus (e.g., glove boxes, piping, and tanks) used for the chemical recovery of plutonium. Test results showed that a primary requirement for a satisfactory coating is ease of decontamination. A closely related concern is the resistance of paint films to nitric acid - plutonium environments. A vinyl copolymer base paint was the only coating, of eight paints tested, with properties that permitted satisfactory decontamination of plutonium and also performed equal to or better than the other paints in the chemical resistance, radiation stability, and impact tests.

26214 Preparation, characterization, and decay of einsteinium(II) in the solid state. Peterson, J.R.; Ensor, D.D.; Fellows, R.L.; Haire, R.G.; Young, J.P. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry; Oak Ridge National Lab., TN (USA)). *J. Phys. (Paris), Colloq.;* No. 4, C4.111-C4.113(1979).

From 3. International conference on electronic structure of the actinides; Grenoble, France (30 Aug - 1 Sep 1978).

Samples of $EsCl_2$, $EsBr_2$, and EsI_2 have been prepared for the first time by reduction of the corresponding einsteinium trihalides with hydrogen gas at elevated temperatures. The three dihalides were characterized primarily by their absorption spectra. The products of the decay of EsX_2 samples held at ambient and liquid helium temperatures have been monitored by spectrophotometry. In all cases positive identification of the granddaughter, CfX_2, species has been made. No definite spectral evidence for the presence of the possible daughter products, BkX_2, has been obtained.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 25458

26215 (AD-A—077395/2) **Phenomenological models of soot processes in combustion systems. Interim report, 1 October 1978-30 September 1979.** Glassman, I. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). 1 Jul 1979. Contract F49620-78-C-0004. 46p. NTIS, PC A03/MF A01.

The fuel sooting trends in pre-mixed and diffusion flames follow opposite directions due to the different influences of temperature. In pre-mixed flames as the temperature rises the rate of oxidative attack on the soot precursors increases faster than the rate of precursor formation through pyrolysis. Thus the higher the temperature the less is the tendency to soot. In the pre-mixed flame all aliphatics form some acetylene which is the monoelement for precursor formation and all fuels essentially follow the same nucleation route. Aromatics oxidize partially through carboxyl radicals formed during attack on the ring and thus aromatic mixtures burn 'richer' than corresponding aliphatic mixtures of the same stoichiometry. The dominant factors in diffusion flames are the temperature and fuel structure. Here the higher the temperature, the greater is the rate of fuel pyrolysis and the propensity to soot. Thus fuel structures which during pyrolysis form strongly conjugated (polar) species most readily soot. A pure acetylenic polymerization route is too slow to predict the early nucleation of soot particles and the presence of ions cannot predict the difference of isomers to soot in diffusion flames. Thus it has been postulated that only conjugated species which have polar resonance structures can undergo the fast reactions necessary.

26216 (AD-A—077563/5) **Radiation augmented combustion. Interim Report, 1 June 1978-31 May 1979.** Cerkanowicz, A.E. (Exxon Research and Engineering Co., Linden, NJ (USA). Government Research Labs.). Jul 1979. Contract F49620-77-C-0085. 33p. NTIS, PC A03/MF A01.

Radiative initiation and enhancement of combustion in unsensitized fuel-air mixtures via the photodissociation of oxygen molecules and combustion intermediary species are being investigated. Pulsed VUV (vacuum ultraviolet) light sources and continuous UV (ultraviolet) light sources are being used for this purpose. Experimental efforts are directed at elucidation of light source conversion efficiency and spectral characteristics, and reactant mixture-photon interactions. A complementary effort involves the development of analytical capability required for modeling photochemical initiation and enhancement of combustion.

26217 (DOE/ER/14953—T1) **Studies of combustion kinetics and mechanisms. Progress report.** Gutman, D. (Illinois Inst. of Tech., Chicago (USA). Dept. of Chemistry). 30 Jan 1980. Contract AS02-78ER14953. 7p. NTIS, PC A02/MF A01.

A pulsed CO_2-TEA laser is used to dissociate free-radical precursors, and a photoionization mass spectrometer is used to monitor the reactions of the radicals. Experiments are in progress to find precursors which can yield alkyl, alkoxy, acetyl, and S or N-containing free radicals. Laser-induced decompositions of ethyl acetate, trifluoroiodomethane, ethyl nitrate, and dimethylsulfoxide have been carried out. (DLC)

26218 (FE—2446-8) **Experimental study of chemically reacting turbulent free shear layers. (Final report, September 23, 1976-November 30, 1978.** Gould, R.K. (Aerochem Research Labs., Inc., Princeton, NJ (USA)). Feb 1980. Contract EX-76-C-01-2446. 55p. NTIS, PC A04/MF A01.

Measurements of species concentrations and their statistical properties at points in well-characterized chemically reacting trbulent flows are required for: (i) testing theories of reacting turbulent systems; and (ii) as input to models which predict the behavior of practical combustors. The model chemical reaction used to study turbulent mixing/reacting flows was the NO/O_3 reaction. A novel photolysis/chemiluminescence technique has been employed to measure reactant concentrations, c/sub NO/ and c/sub O_3/, and a product concentration, c/sub NO_2/, simultaneously at points in the flow field. From such measurements, the required statistical quantities, i.e., probability density functions and correlations of reactants and product concentrations, are obtained. These data have been supplemented by measurements of the turbulence power spectra and intensity throughout the flow. The flow studied was an axisymmetric turbulent jet exhausting into a nearly stationary, uniform channel flow. Two cases were examined: (i) a reacting case in which the jet contains dilute O_3 in N_2 and the channel flow is dilute NO in N_2; and (ii) a nonreacting (but otherwise identical flow) in which a jet of N_2 containing small quantities of NO and NO_2 exhausts into pure N_2. 22 figures, 3 tables.

26219 (FE—3084) **Complete burning and extinction of a carbon particle in an oxidizing atmosphere.** Matalon, M. (Polytechnic Inst. of New York, Farmingdale (USA). Aerodynamics Labs.). May 1980. Contract ET-78-C-01-3084. 46p. NTIS, PC A03/MF A01.

The departure from an equilibrium gas phase behavior is described in order to obtain the rate of mass loss M of a pure carbon particle immersed in an oxidizing atmosphere over a wide range of Damkoehler numbers D/sub g/ (representing either the particle size or the ambient pressure). Unlike the equilibrium limit (D/sub g/ $\rightarrow \infty$) in which M depends solely on the indirect oxidation $C + CO_2$, the present analysis allows a small leakage of oxygen through the flame so that M depends on the direct oxidation $C + O_2$ as well. Furthermore, the structure of a thin but finite flame where the CO oxidation takes place is analyzed and its influence on M is determined. It leads to a minimum value D/sub g/° (or particle size) below which the $CO + CO_2$ flame cannot persist and the gas phase is necessarily frozen. When the flame exists, it stands at a well defined distance from the particle and in particular it can be adjacent to it; this depends on the particle size and on its surface temperature. Both cases were analyzed.

26220 (IS—4727) **Review of organic emissions from selected combustion processes.** Junk, G.A.; Ford, C.S. (Ames Lab., IA (USA)). May 1980. Contract W-7405-ENG-82. 50p. NTIS, PC A03/MF A01.

The 309 organic compounds reported in the literature as emissions from selected combustion processes are tabulated, with 109 originating from coal combustion, 213 from waste incineration and 69 from coal/refuse combustion. The largest percentage of components have been reported to be present in the grate ash from coal combustion, in the stack emissions from waste incineration and in the fly ash from coal/refuse combustion. Quantitative data for specific compounds are very incomplete, even for the more common components such as polycyclic aromatic hydrocarbons and polychlorinated biphenyls.

26221 (LBL—10679) **Numerical simulation of the interaction of a flame with a Karman vortex street.** Karasalo, I.; Chorin, A.J.; Namer, I.; Robben, F.; Talbot, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 24p. (CONF-800408—4). NTIS, PC A02/MF A01.

From Conference of the western states section of the Combustion Institute; Irvine, CA, USA (21 Apr 1980).

A numerical study of a simplified flow configuration modeling the interaction of a laminar flame with a Karman vortex street is presented. The flow is assumed to be inviscid and the flame is modeled as a line source of specific volume with a burning speed which depends on the local curvature. Complete flow fields are calculated as a function of time for various values of the Markstein parameter, vortex shedding frequency, separation and strength. Rho/sub u//rho/sub b/ was 4.0 and the velocity far upstream was set at 60 cm/s for all cases. The essential features of the interaction of a flame with a vortex street are demonstrated, including a deflection of the vortex street ahead of the flame, a development of a flame brush, the deflection of the mean flame position, and the increase in the mean rate of consumption of reactants when the vortices are introduced.

26222 (LBL—10842) **Catalyzed combustion of lean fuel/air mixtures.** Schefer, R.W.; Robben, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 20p. (CONF-800553—1). NTIS, PC A02/MF A01.

From 4. workshop on catalytic combustion; Cincinnati, OH, USA (14 May 1980).

The effect of catalytic surface activity on gas phase and surface reaction ignition temperatures was studied for H_2-, C_3H_8-, and C_2H_6-air mixtures flowing over a platinum and a quartz surface. It was found that the gas phase ignition temperature is a function of catalyst surface reactivity. That is at lower temperatures the quartz surface was essentially noncatalytic and resulted in gas phase ignition temperatures up to 100°K lower than with the platinum surface. At increased surface temperatures the catalytic activity of the quartz surface approached that of the platinum and gas phase ignition temperatures were identical for both surfaces. A detailed study of C_3H_8 oxidation on a platinum surface showed that for temperatures less than 670°K, CO is the primary oxidation product and for temperatures greater than 870°K, complete oxidation to CO_2 occurs. 8 figures.

26223 (SAND—79-8623) **Review of stiffness and implicit finite difference methods in combustion modeling.** Kee, R.J.; Dwyer, H.A. (Sandia National Labs., Livermore, CA (USA); California Univ., Davis (USA). Dept. of Mechanical Engineering). Apr 1980. Contract EY-76-C-04-0789. 42p. (CONF-790828—4). NTIS, PC A03/MF A01.

From 7. international colloquium on gas-dynamics of explosions and reactive systems; Gottingen, F.R. Germany (20 Aug 1979).

Stiffness is a mathematical characteristic which is exhibited in combustion models when some components of their solutions respond quickly to system perturbations whereas others respond slowly. This paper presents a physical interpretation of stiffness in

chemical kinetics modeling. Implicit finite difference methods are known to be effective in finding solutions to stiff problems, and we present here a general overview of the mathematical concepts important to the implementation of implicit methods.

26224 Theoretical analysis of steady, nonadiabatic premixed laminar flames. Margolis, S.B. (Sandia Laboratories, Livermore, California). *Q. Appl. Math.;* **38**: No. 1, 61-89(Apr 1980).

A one-dimensional, steady, non-adiabatic, premixed laminar flame is assumed semi-infinite with the burner at the origin, and the investigation centers on the asymptotic behavior of the temperature and species mass fractions in the burned region near infinity. After a consideration of the general N-species problem, specific results are obtained for the global two-step reaction $\nu_{r}R \rightarrow \mu_{i}I$, $\nu_{i}I \rightarrow \mu_{p}P$, where R, I, P denote reactant, intermediate, and product species, respectively, and ν_{r}, ν_{i}, μ_{i}, μ_{p} are stoichiometric coefficients. Assuming Arrhenius kinetics, it is shown that the classical linearized asymptotic theory is not applicable unless $\nu_{r}=\nu_{i}=1$, in which case the approach to burned equilibrium is an exponential decay. Consequently, a nonlinear theory applicable to arbitrary ν_{r} and ν_{i} is presented which shows that in general the asymptotic decay is algebraic. It is further shown that boundedness of the solution at infinity permits the arbitrary specification of only three boundary conditions on the original sixth-order differential system. This result is illustrated by a comprehensive analytical example and the computational implications for the general N-species problem are discussed.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 26457

26225 (LA—8322-MS) **Investigation of pressure transients in nuclear filtration systems: construction details of a large shock tube.** Smith, P.R.; Gregory, W.S. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 16p. NTIS, PC A02/MF A01.

This report documents the construction of a 0.914-m (36-in.)-dia. shock tube on the New Mexico State University caompus. Highly variable low-grade explosions can be simulated with the shock tube. We plan to investigate the response of nuclear facility ventilation system components to low-grade explosions. Components of particular interest are high-capacity, high efficiency paticulate air (HEPA) filters. Shock tube construction details, operating principles, firing sequence, and preliminary results are reported.

26226 (TAC-HP—79-004) **Heat pipe technology: a bibliography with abstracts. Quarterly update, October-December, 1979.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Mar 1980. 78p. Univ. of New Mexico, Albuquerque.

An update in the Heat Pipe Technology Bibliographic Series is presented. Approximately 100 references on heat pipe theory, uses, design, fabrication, operation and performance are listed. (LCL)

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 26251, 26258, 26267, 26510, 26715

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 25386

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 25403, 25415

26227 (ORNL—5147/R1) **Safety analysis report for packaging (SARP) of the Oak Ridge National Laboratory. TRU curium shipping container.** Box, W.D.; Klima, B.B.; Seagren, R.D.; Shappert, L.B.; Aramayo, G.A. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 102p. NTIS, PC A06/MF A01.

An analytical evaluation of the Oak Ridge National Laboratory Transuranium (TRU) Curium Shipping Container was made to demonstrate its compliance with the regulations governing offsite shipment of packages containing radioactive material. The evaluation encompassed five primary categories: structural integrity, thermal resistance, radiation shielding, nuclear criticality safety, and quality assurance. The results of the evaluation show that the container complies with the applicable regulations.

26228 (SAND—79-1287) **High-speed impact test of an air-transportable plutonium nitrate shipping container.** Yoshimura, H.R.; Pope, R.B.; Leisher, W.B.; Joseph, B.J. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

To obtain information on package response for comparison with other test environments, a high-speed impact test was performed on a modified Federal Republic of Germany 18B plutonium nitrate air-transportable container. The container, modified with reinforcing rings for improved crush resistance around the inner tube assembly, was impacted at a velocity of 137 m/s onto an unyielding surface. Substantial crushing of the foam overpack and extensive deformation of the container cavity occurred, causing release of the liquid surrogate contents from the titanium shipping container. The container damage resulting from the high-speed pulldown test was more severe than that from a 185-m free fall onto a semirigid surface by a similar container or the crush environment produced by a 9-m drop of a 2-Mg block onto the container resting on an unyielding surface.

26229 (SAND—79-1841) **ALARA studies on spent fuel and waste casks.** Sutherland, S.H. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 35p. (TTC—0050). Dep. NTIS, PC A03/MF A01.

In this report, some implications of applying the ALARA concept to cask designs for transporting spent fuel, high-level commercial and defense waste, and remote-handled transuranic waste are investigated. The XSDRNPM, one-dimensional radiation transport code, was used to obtain potential shield designs that would yield total dose rates at 1.8 m from the cask surface of 10, 5, and 2 mrem/h. Gamma shields of depleted uranium, lead, and steel were studied. The capacity of the casks was assumed to be 1, 4, or 7 elements or canisters, and the wastes were 1, 3, 5, and 10 years old. Depending on the dose rate, the cask empty weights and lifetime transportation costs were estimated.

26230 (SAND—79-2354C) **Experimental study of the steady natural convection in a horizontal annulus with irregular boundaries.** Boyd, R.D. (Sandia Labs., Livermore, CA (USA)). 1980. Contract EY-766-C-04-0789. 66p. (CONF-800723—1). NTIS, PC A04/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

The natural convective heat transfer across an annulus with irregular boundaries was studied using a Mach-Zehnder interferometer. The annulus was formed by an inner hexagonal cylinder and an outer concentric circular cylinder. This configuration models, in two dimensions, a liquid metal fast breeder reactor spent fuel subassembly inside a shipping container. During the test, the annulus was filled with a single gas, either neon, air, argon, krypton, or xenon, at a pressure of about 0.5 MPa. From temperature measurements, both local and mean Nusselt numbers (Nu_{Δ}) at the surface of the inner cylinder were evaluated, with the mean Rayleigh number (Ra_{Δ}) varying from 4.54×10^{4} to 0.915×10^{6} (Δ is the local gas width). The data correlation for the mean Nusselt and Rayleigh numbers is given by $\overline{Nu}_{\Delta} = 0.183 \overline{Ra}_{\Delta}^{0.310}$.

26231 (SAND—80-0062C) **Thermal response modeling of a contact-handled transuranic waste shipping container system to a fire.** Suchsland, K.E.; Kwong, K.C.; Fretter, E.F.; Boyd, R.D.; Auerbach, I.; Yoshimura, H.R. (Acurex Corp., Mountain View, CA (USA). Aerotherm Div.; Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 21p. (CONF-800723—5). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Portions of document are illegible.

A one-dimensional thermal model has been developed to predict the response of a transuranic (TRU) waste shipping container accidentally exposed to a fire environment. The basic wall structure of the container consists of polyurethane foam (64 kg/m^{3}) sandwiched between two steel plates. The foam thermal model, based on high temperature experimental data, is developed for the case in which the virgin foam is in a nonoxidizing environment. The experimental results indicate that foam decomposition is highly heat rate dependent. At low quasi-steady heating rates, the foam changes to a bubbling black viscous liquid. At very high heating rates, pyrolysis gases are formed as the foam decomposes and a 20% (by weight) residual char remains. This porous char acts as a radiation shield which can significantly reduce thermal transport. In the case of a TRU shipping container wall, this char will slow the thermal penetration rate and drastically reduce the heat load to the container contents. When the front surface of the wall was subjected to 1333°K, numerical computations predict that after approximately 1800 s the foam temperature rise at a depth of 10.2 cm was less than 200 K (uncharred). After approximately 3600 s the foam temperature rise at a depth of 20.4 cm was 23°K. Typical waste contents temperature rise was predicted to be less than 56°K after 3600 s of heating.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 25238

26232 (COO—4033-19) **Electrodril System Field Test Program. Phase II. Task C. Deep drilling system demonstration. Final report.** (General Electric Co., Houston, TX (USA). Space Div.). Oct 1979. Contract EY-76-C-02-4033. 132p. NTIS, PC A87/MF A01.

This report documents the results of the Phase II, Task C, Electrodril Deep Drilling System drilling demonstrations. Task C, initiated in November 1978, followed the successful completion of the Systems Verification test program and consisted of two drilling demonstrations under operational conditions at two operational well sites. These two demonstrations were conducted in April and June 1979. The criteria established to guide selection of drilling sites for the demonstration is included. The test planning developed for each demonstration site is also included. Accomplishments are delineated as are the post test analyses from both drill sites. The report concludes that, from a technical viewpoint, the fundamental concept of Electrodril remains valid. The post test analyses indicate that the system problems are limited to the connectors and are centered around their manufacturing process. Recommendations for changes in the connector process, inspection and acceptance test are provided. Finally, the testing required to qualify new connectors and demonstrate functional integrity is outlined.

LASERS

REFER ALSO TO CITATION(S) 26272

26233 (AD-A—077319/2) **Inhomogeneous broadening effects in cw chemical lasers. Interim report.** Mirels, H. (Aerospace Corp., El Segundo, CA (USA). Aerophysics Lab.). 28 Sep 1979. Contract F04701-78-C-0079. 69p. NTIS, PC A04/MF A01.

The effects of inhomogeneous broadening on the performance of cw chemical lasers are investigated. A simple two-level vibrational model and a Fabry-Perot resonator are assumed. Laser performance is found to depend on certain parameters. Numerical results are presented for a cw chemical laser with laminar diffusion and with a single longitudinal optical mode. The variation of differential number density and local lasing intensity with streamwise distance and the variation of net laser output power with tuning frequency are presented. The latter exhibits a Lamb dip near linee center, which is in agreement with experimental observations. Thus, in typical devices, inhomogeneous broadening effects become negligible for p > or = O(10) Torr. These effects become important in single longitudinal model lasers operating in the regime p (Torr) < or = O(1) and in lasers wherein the streamwise length of the resonator is short compared with the streamwise length of the positive gain region.

26234 (AD-A—077419/0) **Performance characteristics of a CO_2 waveguide laser.** Lavigne, P.; Otis, G.; Vincent, D. (Defence Research Establishment Valcartier, Courcelette, Quebec (Canada)). Aug 1979. 36p. NTIS, PC A03/MF A01.

A rugged CW CO2 2-mm-diameter laser tube has been developed and its performance analyzed. It has been found that the small-signal gain was optimum when the CO2 partial pressure in a CO2:Xe:He mixture amounted to about 15 torr with the peak value decreasing with the CO2 proportion. Replacement of part of the CO2 by CO resulted in a significant improvement of the laser efficiency. A power extraction of 0.18 W/cm has been achieved at 110 torr with a CO2:CO:Xe:He mixture of 10:20:4:66 in a 9.5-cm-long discharge. There are indications that a better extraction is possible in longer tubes. Use of a grating as one end mirror was sufficient to control the electric field orientation and led to a greater tuning range by limiting the number of oscillating lines. At the present stage, semi-sealed-off operation is possible with a filling period of about 300 hours.

26235 **Nonlinear saturation and thermal effects on the free electron laser using an electromagnetic pump.** Lin, A.T.; Dawson, J.M. (Department of Physics, University of California, Los Angeles, California 90024). EY-76-C-03-0010. *Phys. Fluids;* 23: No. 6, 1224-1228(Jun 1980).

The production of visible laser radiation by a low energy relativistic electron beam (MeV) is most readily accomplished through the use of a high frequency (far infrared) electromagnetic pump (λ/sub r/=$\lambda_0/4\gamma_0^2$); such radiation can be generated by reflecting the radiation the relativistic electron beam generates when it interacts with a rippled static magnetic field. It is important to investigate what limits the efficiency in this situation. It is found that with a weak pump field, the pump energy can be amplified by a factor of $4\gamma^2{}_0$ and the pump intensity by $16\gamma^4{}_0$ with the instability being terminated by pump depletion. With a strong pump field, particle trapping in the longitudial potential wave stops the growth of the instability and the initial momentum spread (temperature) limits the saturation amplitude.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 25177, 26151, 26230

26236 (FE—2700-9) **Heat transfer in a fluidized countercurrent bed. Final report.** Jackson, R. (Houston Univ., TX (USA)). Dec 1979. Contract EF-77-S-01-2700. 126p. NTIS, PC A07/MF A01.

In the steam gasification of coal heat of reaction must be supplied for the endothermic reaction: $C + H_2O = Co + H_2$. A possibility is to supply the heat by feeding preheated particles to the upper surface of a steam-fluidized bed of coal char. Provided these particles are larger and denser than the char particles, they would be expected to pass downward through the bed, approaching thermal equilibrium with the bed particles as they move, and hence giving up heat to the char. They can then be removed from the bottom of the bed, reheated elsewhere, and recycled to the surface. This method of heat supply is used in two proposed processes, namely the Battelle-Union Carbide Ash Agglomerating process and the Conoco Coal Development CO_2-Acceptor process, but clearly it has general utility in supplying heat to endothermic gas-solid reactions. There is very little information available on the performance of systems of this type. The rate at which heat is transferred from the descending particles will depend on the holdup of these particles and on an overall heat transfer coefficient between them and the bed particles. Clearly the holdup will depend on the feed rate of the descending particles, physical properties of the two types of particles and the operating conditions of the bed. For a given particle pair and given operating conditions, there will also be a limiting feed rate for the heat transfer particles beyond which flooding will occur and it will no longer be possible for all the particles fed to pass down through the fluidized bed. The purpose of the present work is to investigate the mechanical aspects of the behavior of systems of this type and to investigate heat transfer rates from the descending particles to the bed, and hence to identify those factors which limit attainable heat transfer rates in practice.

26237 **Heat transfer and fluid flow in regular rod arrays with opposing flow.** Yang, J.W. (Brookhaven National Lab., Upton, NY). pp 149-153 of Fluid flow and heat transfer over rod or tube bundles. Yao, S.C.; Pfund, P.A. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

The heat transfer and fluid flow problem of opposing flow in the fully developed laminar region has been solved analyticaly for regular rod arrays. The problem is governed by two parameters: the pitch-to-diameter ratio and the Grashof-to-Reynolds number ratio. The critical Gr/Re ratios for flow separation caused by the upward buoyancy force on the downward flow were evaluated for a large range of P/D ratios of the triangular array. Numerical resuls reveal that both the heat transfer and pressure loss are not significantly affected by the buoyancy force at Gr/Re ratios less than 100.

MATERIALS TESTING

26238 (UCRL—83322) **Plasticity under combined stress loading.** Wilkins, M.L.; Reaugh, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Feb 1980. Contract W-7405-ENG-48. 8p. (CONF-800804—1). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

The stress-strain fields occurring in pressure vessels and pipes are, in general, combinations of tension and shear. Material specimens tested separately in simple tension and simple shear provide experimental data on the flow stress and failure conditions for these two limiting cases. Presented here are computer simulations of tension and torsion tests corresponding to experiments on aluminum 6061-T651. Aluminum is used as a first step for developing a method to study the plasticity and ductile fracture of reactor grade steel under combined stresses. It is noted that the flow stress differs for plastic flow in tension compared to torsion. A general flow-stress model is derived from the experiments.

ELECTRONIC CIRCUITS AND DEVICES

26239 (BDX—613-2302) **Cost effective system for connecting multiwire cables to printed wiring boards. Final report.** Lewis, F.H. (Bendix Corp., Kansas City, MO (USA)). Mar 1980. Contract AC04-76DP00613. 10p. NTIS, PC A02/MF A01.

The high density wiring used on newer electronic devices requires an improved processing technique to eliminate wiring errors and difficulties in reworking assemblies. For example, one subassem-

bly has three cables and three connectors containing approximately 130 wires that terminate on a printed wiring board (PWB). The board is approximately 50.8 mm wide by 101.6 mm long, contains about 20 components, and interconnects with 8 to 10 wires from other printed wiring assemblies (PWAs). A unique system flexible enough to meet present and future work requirements was developed. The Component Locator System usually is referred to as a Work Director at Bendix. The Work Director shows the exact location for installing the wire on the PWB and codes the Cable Scanner for the correct wire. The Cable Scanner then provides an audible signal when the operator touches the correct wire. This combination of Component Locator System and Cable Scanner eliminates the following operations: marking wires for identification; sorting marked wires when attaching to connectors; electrically checking wire number versus pin number; identifying wires by markings when installing them in the PWB; and determining the proper PWB hole location from a visual aid.

26240 (BDX—613-2368) **Laboratory test system. Final report.** Asher, G.L. (Bendix Corp., Kansas City, MO (USA)). Mar 1980. Contract AC04-76DP00613. 41p. NTIS, PC A03/MF A01.

This project was initiated to develop a laboratory test capability for evaluating new and existing digital product designs. In recent years, Bendix Kansas City has become more active in syppling early development hardware to the design laboratories for evaluation. Because of the more complex electronic designs being used in new components, more highly automated test systems are needed to evaluate development hardware. To meet this requirement, a universal test system was developed to provide both basic test capabilities and flexibility to adapt easily to specific product applications. This laboratory evaluation system will reduce the need to develop complex dedicated test systems for each new product design, while still providing the benefits of an automated system. A special purpose interface chassis was designed and fabricated to permit a standardized interface between the test system and the product application. Connector assignments by system functions provide convenience and function isolation. Standard cables were used to reduce the need for special purpose hardware. Electrical testing of a developmental electronics assembly demonstrated the adaptability of this system for a typical product application. Both the interface hardware and the software were developed for this application.

26241 (BDX—613-2388) **Fabrication for precision mechanisms. Final report.** Gillespie, L.K. (Bendix Corp., Kansas City, MO (USA)). Mar 1980. Contract AC04-76DP00613. 103p. NTIS, PC A06/MF A01.

The fabrication of components and assemblies for miniature precision mechanisms provides a variety of exacting manufacturing challenges. Size alone makes many parts hard to pick up, handle, measure, and install. This same small size causes more distortion or bending during machining, assembly, and welding. Some parts even float on the cleaning and deburring solutions. Tools break easily in very small holes, and surface finishes play an important role in part operation. Twenty-five manufacturing operations were studied to improve the precision of existing machining and assembly techniques. The study included the machining of metals and plastics using techniques new to the manufacture of miniature switches, timers, and actuators. Drilling, tapping, and press-fitting miniature features were evaluated. Fixturing and handling techniques, friction reduction, and the forming of ceramic parts were also studied. Many of the new approaches from this study have been incorporated into existing processes and further refined. Detailed observations have been reported in 33 other Bendix reports and the highlights of those observations are summarized in this study.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 25119, 25120, 25121, 25218, 25269, 25272, 25273, 25274, 25275, 25276, 26052, 26076, 26151

26242 (FE—2357-35) **PFB Coal Fired Combined Cycle Development Program: turbine materials evaluation, March 1980.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Mar 1980. Contract EX-76-C-01-2357. 163p. NTIS, PC A08/MF A01.

This report presents the results of cladding technology development under the Coal-Fired Combined Cycle DOE Project. Clad Alloy Development, involved the selection, fabrication and burner rig evaluation of advanced clad alloy composition diffusion-bonded to IN-738. Testing was conducted for up to 5800 hours at 1600°F in a simulated PFB environment. Metallographic evaluation showed Co-base cladding alloys PFB-5PM and PFB-6PM (aluminided) and Fe-base alloy GE-2541 to be the most corrosion resistant. The formability and fabricability of sheet material was significantly improved for these alloys by utilizing powder metallurgy techniques. Clad Process Development encompassed processing activities to evaluate sheet alloy formability, bucket surface preparation techniques, platform clad forming, and the activated diffusion bonding (ADB) of corrosion resistant tips to MS5001 buckets. The main focus, however, involved comprehensive evaluation of clad composite mechanical properties. The results of tensile, creep-rupture, high cycle fatigue, thermal fatigue, bend and unnotched impact tests over the temperature range 70 to 1600°F are presented for IN-738 clad with GE-2541, IN-671, PFB-5PM and aluminided S-57 and PFB-6PM. The effect of preexposure at 1700°F for 1000 hours was also investigated.

26243 (FE—2473-T7) **DOE cost comparison study: industrial fluidized bed combustion vs conventional coal technology.** Myrick, D.T. (Combustion Engineering, Inc., Windsor, CT (USA). Power Systems Group). 2 Jan 1980. Contract EX-76-C-01-2473. 54p. NTIS, PC A04/MF A01.

This study compares the capital and operating costs of two different industrial boiler technologies, each producing 250,000 lbs steam/hr: Fluidized Bed Combustion (FBC) and Pulverized Coal (PC) combustion used in conjunction with a limestone Flue Gas Desulfurization (FGD) system. Three separate turnkey plant designs have been completed. Two of these plant designs incorporate FBC technology and have been designated FBA-16 and FBV-16. The first FBC design (FBA-16) contains two shop assembled, rail-shippable, fluid-bed boilers capable of producing 125,000 lbs/h each. The second plant design (FBV-16) utilizes a single fluid bed boiler shipped by rail in large sections for field assembly. This single unit is capable of producing 250,000 lbs/h. The third plant design utilizes a conventional pulverized coal (PC) boiler used in conjunction with a C-E Air Quaity Control System (AQCS) limestone scrubber. The FBA-16 and FBV-16 fluid bed designs were found to be competitive with the conventional unit. Capital costs were generated for the three turnkey plant designs just described. The FBA-16, FBV-16, and Conventional Unit plant designs have associated capital costs of $24.4, $22.8, and $24.7 million, respectively. A substantial cost reduction can be realized for plant capacities less than 180,000 lbs steam/h by incorporating a single FBA-16 type boiler. The operating costs for the bed designs are close enough to be considered similar when considering the nature of the study. The efficiency of the fluid bed plant designs can be increased and required capital equipment reduced by improvements to the plant design. Some potential design modifications are outlined. Extensive design and background research was prformed to increase the validity and relevance of this report.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 25389

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 25469, 25470, 25650, 25651, 25652, 25653, 25654

POWER CYCLES

REFER ALSO TO CITATION(S) 25603

STIRLING

26244 (DOE/JPL—1060-33, pp 113-117) **United Stirling P40 engine for solar dish concentrator application.** Ortegren, L.G. (United Stirling, Inc., Alexandria, VA); Sjostedt, L.E. 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The United Stirling P40 engine is a key component in a solar concentrator based energy conversion system, to be demonstrated and tested during 1980-1981. This paper reviews the inherent characteristics of modern Stirling engines and focuses on the baseline P40 double-acting engine. This four cylinder engine is the result of extensive component development work at United Stirling in Sweden, and is also playing key roles in other application programs, notably the DOE/NASA Automotive Stirling Engine program. The extent of modifications required for the solar application is reviewed and performance data are predicted. Finally, the potential of an advanced solar Stirling engine is briefly dealt with.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 26526, 26716, 26723

26245 (LA—8151-PR) **Medium-energy physics program. Progress quarterly report, November 1-January 31, 1979.** van Dyck, O.B.; Dunn, E.D. (comps.). (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 83p. NTIS, PC A05/MF A01.

This quarter covers Cycle 22, with 50 days of accelerator operation for research. The H^+ current was 500 μA at 7.5% duty factor. Target cell A-2 began to fail near the end of the cycle and required major repairs after shutdown. The new A-5 target operated successfully throughout the cycle. The π^0 spectrometer performed well in its first use by an experiment; new pion charge-exchange analog transitions were observed. 12 research reports with significant information were abstracted and indexed individually. 45 figures, 9 tables.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 26257

26246 (BNL—27638) **Coherent instabilities in the 20 TeV ring.** Courant, E.D.; Pellegrini, C. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA)). 1980. Contract AC02-76CH00016. 6p. (CONF-7910125—3). NTIS, PC A02/MF A01.

From 2. ICFA workshop on possibilities and limitations of accelerators and detectors; Les Diablerets, Switzerland (4 Oct 1979).

Some of the limits on the average and peak current in the 20 TeV ring, produced by coherent instabilities are discussed, along with some effects of synchrotron radiation.

26247 (UCID—18633) **Suppression of transverse beam breakup modes in an induction accelerator by gas focusing.** Briggs, R.J. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 7 Apr 1980. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01.

The effect of beam-generated positive ions on the beam-breakup instability in linear electron accelerators is calculated using simple models. The strongly nonlinear dependence of the ion focusing force on radius makes a complete suppression of the mode growth possible, in contrast to solenoidal focusing. The predicted gas pressures for significant stabilization of the mode growth in a machine configuration like ATA is relatively low (10^{-5} to 10^{-4} torr), even for high-Q modes.

26248 **Electron model experiment to study instabilities in long periodic focusing systems for intense beams.** Reiser, M.; Namkung, W.; Brennan, M.A. (Univ. of Maryland, College Park). *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 3, 3026-3028(Jun 1979).

The proposed use of intense beams of high-energy heavy ions for pellet fusion have renewed interest in the problem of space-charge limits in long periodic focusing systems. Recent analytical and numerical studies at Berkeley and NRL for beams with a K-V distribution indicate that instabilities may develop in such systems when the beam currents exceed certain thresholds. Since no relevant experimental data exists with which to compare the theory, we propose an inexpensive, small-scale experiment with a 5-20 kV electron beam to study this problem. The electron beam is injected into a periodic solenoid focusing system consisting of 20 solenoid lenses initially. The pertinent results of beam transport theory are reviewed and the design features of the electron beam experiment are presented.

AUXILIARIES AND COMPONENTS

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 26603, 26717

26249 (BNL—27495) **NSLS dipole power source.** Bagley, G.P. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 13p. (CONF-800624—1). NTIS, PC A13/MF A01.

From Power electronics specialists conference; Atlanta, GA, USA (17 Jun 1980).

Portions of this document are illegible.

An SCR DC to DC converter is described which will operate at an output of 275 kW and will supply current to electron storage ring magnets requiring 5 h stability of 50 ppM. The operation of this modified chopper is described and design equations are presented, along with the system control loop description.

26250 (LA-UR—80-1360) **Spallation target-moderator-reflector studies at the Weapons Neutron Research facility.** Russell, G.J.; Gilmore, J.S.; Prael, S.D.; Robinson, H.; Howe, S.D. (Los Alamos Scientific Lab., NM (USA); Kansas State Univ., Manhattan (USA)). 1980. Contract W-7405-ENG-36. 26p. (CONF-800551—9). NTIS, PC A03/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Basic neutronics data, initiated by 800-MeV proton spallation reactions, are important to spallation neutron source development and electronuclear fuel production. Angle-dependent and energy-dependent neutron production cross sections, energy-dependent and total neutron yields, thermal and epithermal neutron surface and beam fluxes, and fertile-to-fissile conversion ratios are being measured. The measurements are being done at the Weapons Neutron Research facility on a variety of targets and target-moderator-reflector configurations. The experiments are relevant to the above applications, and provide data to validate computer codes. Preliminary results are presented and compared to calculated predictions. 13 figures.

26251 (LBL—10950) **Structural analysis of superconducting bending magnets.** Meuser, R.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 6p. (CONF-800631—3). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

Mechanical stresses, displacements, and the effects of displacements upon aberrations of the magnetic field in the aperture have been calculated for a class of superconducting bending-magnet configurations. The analytical model employed for the coil is one in which elements are free to slide without restraint upon each other, and upon the surrounding structure. Coil configurations considered range from an idealized one in which the current density varies as cosine theta to more realistic ones consisting of regions of uniform current density. With few exceptions, the results for the more realistic coils closely match those of the cos θ coil.

26252 (UCID—18630) **Reduction of the beam breakup mode Q values in the ETA/ATA Accelerating Cells.** Birx, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 May 1980. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01.

Earlier Microwave Measurements of the ETA Accelerating Cells has uncovered eleven resonances in the frequency range of $0 > 850$ MHz. The Q values of these modes ranged from 14 to 70. A three phase program directed at substantially reducing these Q values is reported. In particular the dampening methods described below resulted in a decrease of Q value from 40 to 5 for the beam breakup mode (TM_{110}) with a corresponding reduction for most of the other cavity modes.

26253 (UCID—18631) **Preliminary assessment of the electromagnetic environment in the immediate vicinity of the ETA accelerator.** Cabayan, H.S.; Bogdan, E.; Zicker, J.; Wythe, D.; Burke, G.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1980. Contract W-7405-ENG-48. 116p. NTIS, PC A06/MF A01.

The electromagnetic fields in the immediate vicinity of the Experimental Test Accelerator (ETA) at the Lawrence Livermore Laboratory have been characterized. Various EM sensors that cover the frequency band from the very low frequencies up into the GHz region have been used. The report describes in detail the probes, the test set-up and the data processing techniques.

26254 **Fermilab: operation resumes in meson area; fast neutron therapy.** *CERN Cour.;* **19**: No. 5, 198-200(Jul-Aug 1979).

Improvements and modifications in the Meson Area at Fermilab are described. The target train was rebuilt and energy range of some beams raised to 400 GeV with provisions for Tevatron beams of 1000 GeV in the future. The work of the fast neutron therapy facility is summarised.

26255 **Fermilab: operation successes; old accelerators never die.** *CERN Cour.;* **19**: No. 3, 111-113(May 1979).

A summary of recent figures for performance and reliability of the Fermilab accelerator is presented. The use of magnets from the Brookhaven Cosmotron in a new muon spectrometer at Fermilab is reported.

26256 **Los Alamos: meeting on neutron sources.** *CERN Cour.;* **19**: No. 3, 113-114(May 1979).

A report of topics discussed at the International Collaboration on Advanced Neutron Sources meeting held at Los Alamos, March 1979 is given. The design, operation and uses of various pulsed spallation neutron sources are described.

STORAGE RINGS

26257 (BNL—27756) **Estimate of the coupling impedance for the storage rings of the NSLS.** Ruggiero, A.G. (Brookhaven National Lab., Upton, NY (USA)). Aug 1979. Contract AC02-76CH00016. 28p. NTIS, PC A03/MF A01.

The most important ingredient to evaluate the stability of a particle beam in a storage ring is the longitudinal coupling impedance Z/n and the transverse impedance Z/sub perpendicular/ which is usually associated to the former. These impedances are calculated for the two storage rings which are part of the NSLS, namely the Ultra Violet Ring (UVR) and the X-Ray Ring (XRR)-the parameters for these two rings which are used throughout the paper are shown.

26258 **Core/coil assembly for use in superconducting magnets and method for assembling the same.** Kassner, D.A. (to Dept. of Energy). US Patent 4,166,990. 4 Sep 1979. Filed date 12 Aug 1977. 8p.

PAT-APPL-824,192.

A core/coil assembly is disclosed for use in a superconducting magnet of the focusing or bending type used in syncronous particle accelerators comprising a coil assembly contained within an axial bore of the stacked, washer type, carbon steel laminations which comprise the magnet core assembly, and forming an interference fit with said laminations at the operating temperature of said magnet. Also a method is presented for making such core/coil assemblies comprising the steps of cooling the coil assembly to cryogenic temperatures and drawing it rapidly upwards into the bore of said stacked laminations.

INSTRUMENTATION

RADIATION INSTRUMENTATION

REFER ALSO TO CITATION(S) 26316

GENERAL DETECTORS AND MONITORS

26259 (LBL—10039) **Limited-angle imaging in positron cameras: theory and practice.** Tam, K.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 164p. NTIS, PC A08/MF A01.

The principles of operation of planar positron camera systems made up of multiwire proportional chambers as detectors and electromagnetic delay lines for coordinate readout are discussed. Gamma converters are coupled to the wire chambers to increase detection efficiency and improve spatial resolution. The conversion efficiencies of these converters are calculated and the results compare favorably to the experimentally measured values.

26260 (UCRL—84109) **Design and implementation of a fiber-optic gamma-measurement system.** Reedy, R.P.; Crawford, D.W.; Roeske, F. Jr. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 19 May 1980. Contract W-7405-ENG-48. 10p. (CONF-800719—1). NTIS, PC A02/MF A01.

From International symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA, USA (28 Jul 1980).

The design and implementation of the downhole portion of a measuring system for gamma rays is presented. Included are three alternative designs for radiation-resistant collimating and condensing lenses, sample cells, turning mirrors, and fiber-optic termination techniques. Also discussed are mechanical mounts and positioners, shielding, alignment, test methods, and field installation. Some general design suggestions for optical systems in adverse environments are also presented.

26261 **Real-time alpha-in-air monitoring system.** Agopsowicz, D.E.; Newton, G.J. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM (USA). Inhalation Toxicology Research Inst.). *Health Phys.;* **37**: No. 3, 379-382(Sep 1979).

A real-time detector was developed to monitor concentrations of aerosolized alpha-emitting radionuclides such as PuO_2 used for animal exposure experiments. This detector determines aerosol concentration using no filter or other collection media. Sample aerosol is passed through an inlet jet where it is bounded by an annular sheath of clean air. The aerosol is drawn through a ZnS-lined detection cavity in a lucite cube. Scintillation photons produced by the interaction of alpha particles with the ZnS traverse the lucite light pipe to an attached photomultiplier tube. Contamination of the ZnS is prevented by the layer of sheath air between the aerosol and cavity walls. A rate meter or scaler can quantify the aerosol concentration directly. Counting efficiencies of 1.3-1.6 cpm per nCi/l were achieved using ^{239}Pu dioxide aerosol.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 26174

26262 **Comparison of fast neutron-induced tracks in plastics using the electrochemical etching method.** Cotter, S.J.; Gammage, R.B.; Thorngate, J.H. (Oak Ridge National Lab., TN (USA)); Ziemer, P.L. *Health Phys.;* **37**: No. 3, 355-377(Sep 1979).

Four plastics were examined by the electrochemical etching method for their suitability in registering fast neutron-induced recoil particle tracks. The plastics were cellulose acetate, cellulose triacetate, cellulose acetobutyrate and polycarbonate. Cellulose acetate and triacetate displayed high levels of water absorptivity during etching while the acetobutyrate foils cracked due to electromechanical stresses at high frequencies (>500 Hz). The clarity of the etched track was superior in the polycarbonate foils, suggesting the latter as the generally preferred dosimeter for fast neutrons.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

26263 **γ-ray energies for ^{228}Ra-^{228}Ac decay and the ^{228}Th decay chain.** Helmer, R.G. (Idaho National Engineering Lab., Idaho Falls (USA)). *Nucl. Instrum. Methods;* **164**: No. 2, 355-362(15 Aug 1979).

The energies of over 100 γ rays from the decay of ^{228}Ra-^{228}Ac have been determined in order to provide calibration energies for Ge(Li) and Ge semiconductor spectrometers. The γ-ray energies extend from 57 to 1965 keV. Six γ-ray energies from the daughters of ^{228}Th have also been determined.

26264 **Some investigations of moderators for slow positron beams.** Lynn, K.G.; McKee, B.T.A. (Brookhaven National Lab., Upton, NY (USA)). *Appl. Phys.;* **19**: No. 3, 247-255(Jul 1979).

Measurements were made on a low-energy positron beam apparatus in an attempt to increase the efficiency of the slow positron yield from radioisotopes. A study was made to sweep thermalized positrons to the surface of a silicon wafer with an applied electric field at 298 and 140 K. Temperature studies were also made on more conventional Pt and Pt + MgO powder moderators and the results are discussed. The role of the MgO powder has been clarified, though fundamental questions remain. The positron apparatus beam and relevant information regarding sources, temperature and magnetic fields are discussed in sufficient detail so that such a slow positron beam utilizing a 'conventional' slow positron moderator could be easily duplicated for use in solid state studies.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 26600, 26603

26265 (LBL—10822) **Apparatus to detect stable fractional charges on matter.** Vanderspek, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 23p. NTIS, PC A02/MF A01.

The construction of an apparatus designed to detect stable fractional charges on matter, if they exist, to the level of 10^{-24} per nucleon is reported and discussed. The charges on a stream of highly consistent droplets produced by the apparatus are determined by accurate measurement of the deflection of the droplets in falling through a static electric field. Maintenance of certain parameters of operation calculated to limit the random effects of electrical and aerodynamical disturbances on the droplets indicate a precision in the measurement of the charge on a droplet of 0.02e can be attained. 7 figures.

26266 **Right/left assignment in drift chambers and proportional multiwire chambers (PWC'S) using induced signals.** Walenta, A.H. (to Dept. of Energy). US Patent 4,179,608. 18 Dec 1979. Filed date 10 May 1978. 6p.

PAT-APPL-904,678.

An improved multiwire chamber is described which has means for resolving the left/right ambiguity in the location of an ionizing event. The chamber includes a plurality of spaced parallel anode wires positioned between spaced planar cathodes. Associated with each of the anode wires are a pair of localizing wires, one positioned on either side of the anode wire. The localizing wires are connected to a differential amplifier whose output polarity is determined by whether the ionizing event occurs to the right or left of the anode wire.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 25209, 25224, 25948, 26095, 26153

26267 **Bimetallic strip for low temperature use.** Bussiee, J.F.; Welch, D.O.; Suenaga, M. US Patent Application 064,595. [nd]. 13p.

A class of mechanically pre-stressed structures is provided suitably bi-layer strips, consisting of a layer of group 5 transition metals in intimate contact with a layer of an intermetallic compound of transition metals with certain group 3A, 4A or 5A metals or metalloids such as Ga, In, Si, Ge, Sn, As or Sb. The changes of Young's modulus of these bi-layered combinations at temperatures in the region of somewhat above absolute zero provides a useful means of sensing temperature changes. Such bi-metallic strips may be used as control strips in thermostats, or in direct dial reading instruments. The structures are made by preparing a sandwich of a group 5B transition metal strip between the substantially thicker strips of an alloy between copper and a predetermined group 3A, 4A or 5A metal or metalloid, holding the three layers are heated, cooled the copper alloys and is removed. Removing one of the two formed interlayer alloys between the transition metal and the metal previously alloyed with copper remain.

26268 (CONF-790947—2) **In-service inspection for steam generator tubing using multiple frequency eddy-current techniques.** Dodd, C.V.; Deeds, W.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01.

From Symposium on eddy current characterization of materials and structures; Gaithersburg, MD, USA (5 Sep 1979).

A rapid, accurate, and easy-to-use inspection method for steam generator tubes is clearly needed and not entirely provided by our present eddy-current tests. The signals from eddy-current tests are affected by changes in tube wall thickness, the location and size of defects, the electrical conductivity, the magnetic permeability, and the tube-to-tube support spacing and denting (which changes the probe to tube spacing). Simultaneous variations in these test properties produce signals that are ambiguous in present commercial eddy-current instruments. However, this type of multiple property eddy-current testing can be done using pulsed techniques or multiple frequencies. A systematic, automated process has been developed at ORNL to allow rapid development of accurate multiple property eddy-current tests.

26269 (CONF-800626—6) **Transmission diffraction gratings for the 20 to 200 eV region.** Caldwell, P.J.; Arakawa, E.T. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From 6. international conference on vacuum ultraviolet radiation physics; Charlottesville, VA, USA (2 Jun 1980).

The construction procedure of a new type of transmission diffraction grating is outlined and the results of tests using a condensed spark source and synchrotron radiation are presented. (GHT)

26270 (EPRI-NP—1322) **Demonstration of fiber optic link applications in utility plant multiplexed instrument and control systems. Final report.** Redus, W.D.; Craig, G.R.; Oldham, W.J.B. (E-Systems, Inc., Greenville, TX (USA)). Jan 1980. 111p. NTIS, PC A06/MF A01.

The application of data transmission via fiber optic cables was demonstrated for a utility plant instrumentation system at the Bergen Generating Station. The fiber optic system (FOS) was designed, fabricated, and tested by E-Systems, Inc., Greenville Division, located in Greenville, Texas, using commercially available components. Plastic fiber optic cables were evaluated for short run applications up to 140 ft and glass fiber optic cables were evaluated for long run applications up to 1330 ft. The FOS and fiber optic cables were installed, operated, and maintained with technical input from E-Systems, Inc. The demonstration was conducted over a ten month period.

26271 (LBL—10682) **US Atom-Resolving Microscope Project.** Gronsky, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 7p. (CONF-800801—1). NTIS, PC A02/MF A01.

From 39. annual meeting of the Electron Microscopy Society of America and the 15. annual meeting of the Microbeam Analysis Society; San Francisco, CA, USA (4 Aug 1980).

The largest project in transmission electron microscopy in this country has recently been initiated. This project has been given the name Atomic Resolution Microscopy and its goal is to provide the instrumentation and expertise necessary to conduct materials research directly at the atomic level. Taking advantage of the best available technology in electron-optical design, its core instrumentation is a unique machine, the Atomic Resolution Microscope (ARM), which is to be built by commercial manufacturers to the specifications of LBL and used in basic research programs requiring atomic imaging capabilities. The project will also include an in-house instrument development effort to maintain state-of-the-art performance from the ARM. Details of history, organization and performance specifications are given.

26272 (SAND—75-0287C) **Technique for precise alignment of small diameter lasers.** McCarthy, A.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 3p. (CONF-800719—2). NTIS, PC A02/MF A01.

From International symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA, USA (28 Jul 1980).

This report describes one technique used to obtain precise alignment of small diameter lasers. This procedure may be useful in the alignment of other lasers, but is especially valuable when aligning lasers that have a small diameter active medium and/or a curved mirror at one end of the laser cavity. The technique described in this report uses a He-Ne laser at one end of the laser being aligned and an autocollimator at the opposite end. These instruments are used to generate and observe the diffraction pattern and interference fringes caused by the limiting aperture of the lasing medium and the end mirrors of the cavity, respectively. These patterns and fringes are used both to establish a common optical axis between the active volume of the laser being aligned and the aligning instruments, and to set the end mirrors of the cavity normal to this axis.

26273 (SAND—80-0026) **Coded aperture imaging system for nuclear fuel motion detection.** Stalker, K.T.; Kelly, J.G. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 11p. (CONF-800453—1). Dep. NTIS, PC A02/MF A01.

From International optical computing conference; Washington, DC, USA (7 Apr 1980).

A Coded Aperature Imaging System (CAIS) has been developed at Sandia National Laboratories to image the motion of nuclear fuel rods undergoing tests simulating accident conditions within a liquid metal fast breeder reactor. The tests require that the motion of the test fuel be monitored while it is immersed in a liquid sodium coolant precluding the use of normal optical means of imaging. However, using the fission gamma rays emitted by the fuel itself and coded aperture techniques, images with 1.5 mm radial and 5 mm axial resolution have been attained. Using an electro-optical detection system coupled to a high speed motion picture camera a time resolution of one millisecond can be achieved. This paper will discuss the application of coded aperture imaging to the problem, including the design of the one-dimensional Fresnel zone plate apertures used and the special problems arising from the reactor environment and use of high energy gamma ray photons to form the coded image. Also to be discussed will be the reconstruction techniques employed and the effect of various noise sources on system performance. Finally, some experimental results obtained using the system will be presented.

26274 (SAND—80-0203C) **VISAR studies of a reefing line cutter.** Lieberman, M.L.; Wilson, R.S. (Sandia National Labs., Albuquerque, NM (USA); Systems, Science and Software, La Jolla, CA (USA)). 1980. Contract EY-76-C-04-0789. 17p. (CONF-800713—11). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The VISAR has been used to study the output performance of a pyrotechnic-driven reefing line cutter. Velocity-time and displacement-time profiles were obtained during blade motion, both with and without the reefing line present. The data yielded measures of the utilization of the blade's momentum and kinetic energy. Units of two different designs were tested. Those that leaked gas yielded considerably lower kinetic energy and momentum values. The VISAR data also showed evidence that gas leakage in such units occurs prior to, or during, the initial several millimeters of blade displacement.

26275 **Flash x-ray tube for diffraction studies on a two-stage light-gas gun.** Johnson, Q.; Mitchell, A.C.; Smith, I.D. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Rev. Sci. Instrum.;* **51**: No. 6, 741-749(Jun 1980).

A flash x-ray tube has been fabricated and has been driven by a Blumlein pulse generator to peak voltages of 60 to 80 kV and peak anode currents of 8 to 10 kA. The pulse width, dependent upon the anode-cathode spacing, can be made ~80-ns wide, and a small spot or line focus is possible. These features make the device useful for flash x-ray diffraction studies. Current in the diode region exceeds the calculated space-charge limited values, probably because of neutralization of charge by plasma ejected from the cathode during the initial phase of the discharge.

26276 **Spectrometer employing optical fiber time delays for frequency resolution.** Schuss, J.J.; Johnson, L.C. (to Dept. of Energy). US Patent 4,164,373. 14 Aug 1979. Filed date 12 Jan 1978. 12p. PAT-APPL-868,952.

This invention provides different length glass fibers for a broad range of optical time delays for short incident chromatic light pulses for the selective spatial and frequency analysis of the light with a single light detector. The frequencies of the incident light are orientated and matched with the different length fibers by dispersing the separate frequencies in space according to the respective fiber locations and lengths at the input terminal of the glass fibers. This makes the different length fibers useful in the field of plasma physics. To this end the short light pulses can be scattered by a plasma and

then passed through the fibers for analyzing and diagnosing the plasma while it varies rapidly with time.

26277 Micro-magnetic susceptometer for the actinides. Nave, S.E. (Tennessee Univ., Knoxville (USA). Dept. of Physics); Huary, P.G. (Oak Ridge National Lab., TN (USA)). *J. Phys. (Paris), Colloq.;* No. 4, C4.114-C4.115(1979).

From 3. International conference on electronic structure of the actinides; Grenoble, France (30 Aug - 1 Sep 1978).

A d.c. magnetic susceptometer incorporating a S.Q.U.I.D. as a magnetic flux sensor has been constructed with sensitivity to measure the magnetic susceptibility of submicrogram actinide samples as a function of temperature. For a two microgram actinide sample the minimum measurable dimensionless susceptibility is approximately 10^{-7} CGS in a 2000 gauss field. The sensitivity has been determined in a series of calibration experiments using samples of lead spheres at 4.2 K. Pick-up coils insensitive to changes in spatially uniform fields and fields with a constant first derivative were used to reduce noise. The field was trapped in a niobium cylinder to produce a uniform stable applied field. The flux produced by the sample in the pick-up coils is proportional to the magnetic susceptibility of the sample and is a function of the sample position.

26278 Digitization noise in Fourier transform infrared spectroscopy and gain ranging. Hirschfeld, T. (Block Engineering, Inc., Cambridge, MA). *Appl. Spectrosc.;* 33: No. 5, 525-527(1979).

The signal/noise ratio attained in Fourier transform infrared spectroscopy is examined. It is found that the generally accepted theoretical maximum can be significantly exceeded; improved theory is developed. Occasions for the use of gain ranging are discussed. 1 figure. (RWR)

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 26289

26279 (AD-A—077535/3) **Thermal initiation of high explosives with an electron beam. Final report.** Stolovy, A.; Jones, E.C. Jr; Aviles, J.B. Jr; Namenson, A.I. (Naval Research Lab., Washington, DC (USA)). 8 Nov 1979. 13p. NTIS, PC A02/MF A01.

The condition under which high explosives undergo thermal initiation were studied under dynamic conditions by measuring the temperature of samples while they were irradiated by 40-MeV electrons at the NRL Linac. Values were obtained for the thermal initiation threshold and the explosion temperature for the following high explosives: Composition B, TATB, HBX-1, PBX-9404 and Pentolite. Theoretical values based upon a single rate Arrhenius formula are in reasonable agreement with the experimental results.

26280 (MHSMP—80-14) **Low chlorine TATB produced by emulsion amination.** Locke, J.G. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1980. Contract AC04-76DP00487. 6p. NTIS, PC A02/MF A01.

A pilot plant process for amination of sym-trichloro-trinitrobenzene (TCTNB) in the presence of an emulsifier and water to sym-triaminotrinitrobenzene (TATB) has been developed. This process produces TATB with chlorine contents similar to that of wet-amination but allowing improved control of particle size.

26281 (MHSMP—80-16) **RX-26-AW/AX rifle bullet tests.** Sharp, D.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Apr 1980. Contract AC04-76DP00487. 11p. NTIS, PC A02/MF A01.

A series of rifle bullet tests was performed at the request of LLL for two explosives, RX-26-AW and RX-26-AX, using the Pantex version of the Picatinny Arsenal test (PA-2). Both exposives tested displayed essentially the same low sensitivity to bullet impact. Slow burning of the explosive was the highest order of reaction observed. Also, in a continuing effort to improve the capability of the test facility, different rifle sighting and shot alignment procedures were implemented during this test series.

26282 (MHSMP—80-19) **Formulation of custom sized LX-15 granules.** Stull, T.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Apr 1980. Contract AC04-76DP00487. 8p. NTIS, PC A02/MF A01.

LX-15 is a booster explosive formulation consisting of 95% HNS I and 5% Kel F-800 developed by Lawrence Livermore Laboratory. The purpose of this effort was to develop formulation techniques for the production of custom size granules that are amenable for processing in automatic weighing equipment. This report details processes whereby 0.4 and 1.5 kg size batches are produced, meeting those requirements. Efforts to date have found that granule size is dependent on batch/vessel size, water-to-solvent ratio and the degree of vessel agitation.

26283 (SAND—79-1674) **PUFF TOO: a residual stress experiment.** Smith, C.W. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 85p. NTIS, PC A05/MF A01.

Following the passage of the dynamic effects in a contained explosive detonation, there remains a strong compressive stress field in the material about the cavity. In this experiment, a 454-kg (1000 lb) sphere of high explosive was detonated in saturated ashfall tuff. Instrumentation measured peak stresses over the range of 0.1 to 6.0 GPa (1 to 6 kbar) and the complete stress-time waveform, including the so-called residual stress, at the 0.1 GPa (1 kbar) peak stress range. Mineback revealed detonation-induced fractures and fractures induced by postevent work.

26284 (SAND—80-0204C) **Status of the development of 2-(5-cyanotetrazolato) pentaamminecobalt(III) perchlorate for DDT devices.** Lieberman, M.L.; Fronabarger, J.W. (Sandia Labs., Albuquerque, NM (USA); Unidynamics, Phoenix, AZ (USA)). 1980. Contract AC04-76DP00789. 34p. (CONF-800713—12). NTIS, PC A03/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The inorganic explosive 2-(5-cyanotetrazolato) pentaamminecobalt(III) perchlorate (CP) was synthesized by conventional coordination chemistry preparative methods. Its structure has been established via ^{15}N NMR spectroscopy and x-ray diffraction techniques. Impurities have been identified and characterized. Procedures for qualification of the powder for detonator use have been established. Investigations of thermal properties are underway and no corrosion or compatibility problems have been determined under normal detonator environments. The physics of deflagration-to-detonation transition (DDT) of CP is being addressed. Studies are in progress to determine the shock characteristics of unreacted material, detonation parameters, equation of state of the reaction products, and characteristics of the transition to detonation. Engineering considerations have included measurements relating CP particle size, compaction behavior, spark sensitivity, shock sensitivity thermal ignition sensitivity, growth-to-detonation in device hardware, and output. 14 figures, 3 tables.

NUCLEAR

REFER ALSO TO CITATION(S) 26320, 26323

26285 (AD-A—077491/9) **Bikini scientific resurvey. Volume III. Report of the director of ship material.** (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 48p. NTIS, PC A03/MF A01.

Inspections were made of the following sunken target ships: SARATOGA, PILOTFISH, APOGON, and NAGATO. A large number of photographs were made to supplement the inspections of the divers. Some of these photographs are incorporated in the body of the following report. Other pictures of less obvious value have been placed in the Annexes which accompany reports on the various ships, and the remainder have been preserved in an Appendix with the thought that some of them might reveal worth-while data upon expert examination.

26286 (AD-A—077492/7) **Bikini scientific resurvey. Volume III. Report of the director of ship material. Annex I. USS Saratoga (CV-3). Technical report.** (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 212p. NTIS, PC A10/MF A01.

Ship characteristics of the USS SARATOGA (CV-3), are listed. A general and detailed description of damage is included for the SARATOGA which was found sunk in from 27 to 34 fathoms of water.

26287 (AD-A—077493/5) **Bikini scientific resurvey. Volume III. Report of the director of ship material. Annex II. USS Pilotfish (S.S.-386). Technical report.** (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 126p. NTIS, PC A07/MF A01.

The USS PILOTFISH was built of heavy hull construction at Portsmouth Naval Shipyard and was commissioned 16 December 1943. Ship characteristics are listed. A general and detailed description of damage is included for the USS PILOTFISH which was found sunk in about 29 fathoms of water, with the hulk buried in the bottom to about 12 ft. to 15 ft.

26288 (AD-A—077508/0) **Remote radiological monitoring.** Sigoloff, S.C.; Borella, H.M. (USAEC, Washington, DC). Oct 1957. 85p. NTIS, PC A05/MF A01.

A gamma-radiation telemetering system was utilized by Civil Effects Test Group personnel to measure fallout levels at the Nevada Test Site from the vicinity of Ground Zero out to, and including, an area bounded by Reno, Nev.; Salt Lake City, Utah,

Kingman, Ariz.; and Barstow, Calif. Two methods of signal transmission were used; direct-coupled field lines for on-site installations and commercial telephone lines for areas to 330 miles. Graphic and tabular data cover on-site and off-site residual gamma-radiation dose rate measurements taken as function of time after selected events.

26289 (SAND—79-1829) **Initiation and gas expansion model for the light-initiated explosive silver acetylide-silver nitrate.** Benham, R.A. (Sandia Labs., Albuquerque, NM (USA)). Feb 1980. Contract EY-76-C-04-0789. 44p. Dep. NTIS, PC A03/MF A01.

Light-initiated high explosive, silver acetylide-silver nitrate (SASN), has been used to produce simulated X-ray blowoff impulse loading on reentry vehicles to study the system structural response. A model of the explosion process is required for estimating the average pressure profile delivered to the surface during the loading. A simplified model of the initiation and gas expansion process of the explosion is described. Observations from several experiments in which thin metallic flyer plates were accelerated with SASN were used to develop the model. Predictions of the approximate average pressure-time loading on the surface of a test structure is now possible. The pressure-time model can also be used to predict the motion of explosively driven thin solid flyer plates.

WEAPONRY

26290 (SAND—80-0248) **Comparison of experimental and computational results for reverse ballistic tests into foundry core.** Yarrington, P.; Norwood, F.R.; Grady, D.E. (Naval Training Equipment Center, Orlando, FL (USA)). Mar 1980. Contract AC04-76DP00789. 55p. NTIS, PC A04/MF A01.

A series of nine laboratory-scale penetration tests was conducted in which impact velocity and geometry of the projectile were varied. In all tests, displacement histories were obtained for the penetrator via displacement interferometric techniques. From the data, accelerations were deduced and compared with numerically-calculated accelerations. For the numerical work, the codes PENAP and WONDY were used to model the penetration events. For penetrators with a conical nose, agreement between calculated and measured accelerations could be brought within 15% for all tests, except for one PENAP/test comparison, by introducing a constant coefficient of Coulomb friction of 0.1 at the penetration target interface. For penetrators with an ogival nose, on the other hand, a greater discrepancy was found between calculated and measured results.

EXPLOSION DETECTION

REFER ALSO TO CITATION(S) 26260

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

26291 (COO—2195-34) **Climatic changes and variations: a geophysical problem.** Newell, R.E.; Chiu, L.S. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 1980. Contract AS02-76EV12195. 37p. NTIS, PC A03/MF A01.

The morphology of, and the physical factors that control, the seasonal changes in global free air temperature and sea surface temperature are discussed. Non-seasonal tropical free air temperature changes are related to preceeding changes in tropical sea surface temperature and to volcanic aerosol while the tropical sea surface temperature itself is related to changes in surface pressure which characterize the Southern Oscillation. Zonal wind variations at low latitudes accompany the latter variations. The main variability in tropospheric temperature at high latitudes is characterized by the Greenland seesaw. The injection of volcanic aerosol by the eruption of Mt. Agung in March 1963 into the stratosphere gives rise to temperature increases of up to 5°C in the stratosphere and cooling of 1°C in the troposphere. The third major climatic signal in the recent record - the so called Biennial oscillation - is also briefly reviewed.

26292 (COO—2195-36) **Influence of volcanic aerosols and oceanic surface temperatures on tropospheric temperatures.** Navato, A.R. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 1979. Contract AS02-76EV12195. 13p. NTIS, PC A02/MF A01.

For many years climatologists have been aware of the influence of the presence of volcanic dust and aerosol in the atmosphere on tropospheric temperatures. The influence of oceanic sea surface temperatures (SST) on tropospheric temperatures has also been investigated. However, none of the previous studies included the Indian Ocean. This report summarizes results of a study to estimate the sensitivity of the tropical (20°N to 20°S) tropospheric temperatures (TTT) to SST's of the Pacific Ocean, Atlantic Ocean, and Indian Ocean, and to atmospheric dust and aerosol concentrations over the northern tropics and over the southern hemisphere.

26293 (LA-UR—80-791) **Effective transport velocity and plume elongation in nocturnal valley wind fields.** Clements, W.E.; Barr, S.; Fowler, M.M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800327—8). NTIS, PC A02/MF A01.

From 2. joint conference on applications of air pollution meteorology; New Orleans, LA, USA (24 Mar 1980).

Using three atmospheric tracers the effective transport velocity and plume elongation produced by nocturnal drainage wind in three different valleys were investigated. Tracer was released in each valley in a well defined drainage wind field and sequentially sampled at downvalley locations. The effective transport velocity (V-eff) was determined from the elapsed time from the start of the release to the time when the plume concentration reached 10% of its peak value and the distance from the release site. The plume elongation factor was determined from the ratio of the width (time) of the plume at 10% of its peak value to the duration of the release. This method was chosen as an objective analysis scheme. Mean measured winds (V) were computed from surface wind instruments along the drainage flow path with values weighted by the estimated time the plume was in the wind field best represented by a measurement. The values used were from the start of release to the time of arrival at the sampler in question. V is compred to V-eff to see how reasonable an estimate of plume transport in valleys can be made from a few surface measurements in the valley. The simple tracer technique used in the studies has proven to be a good one in accomplishing the stated objective of investigating effective transport velocity and plume elongation in nocturnal valley drainage winds.

26294 (LA-UR—80-792) **Comparison of atmospheric temperature structure at the wall and in the middle of a valley.** Barr, S.; Clements, W.E.; Wilson, S.K. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800327—7). NTIS, PC A02/MF A01.

From 2. joint conference on applications of air pollution meteorology; New Orleans, LA, USA (24 Mar 1980).

Previously reported results indicate that measurements of temperatures near ground level on hillsides and valley walls serve as a reasonable approximation to the ambient nocturnal lapse rates. At Anderson Creek Valley in the Geysers area of California temperatures on the valley wall were compared with temperature profiles in the middle of the valley. An ensemble of temperature measurements including vertical soundings and surface based measurements from fixed stations and a mobile unit were analyzed. Although intercalibration was not rigorously conducted between the various systems, each system was calibrated independently and sufficient agreement exists when sensors were co-located to support confidence in the measurements. Surface measurements at various altitudes in Anderson Creek Valley were as much as 10°C cooler than the temperature in mid-valley at the same altitude. The departures were smallest in the early evening and grew during the night. The cold air was quite shallow and if care were taken to make ground-based measurements on promontaries or towers, the gross stability could be characterized by surface temperature observations up the side of the valley. A more promising analysis of the data is to interpret the thermal gradients from the valley wall to the center in terms of the driving force they provide to the drainage flow. The circulations theorem of Bjerknes provides the link between the stable temperature gradients on sloping ground and the velocity field through pressure-density solenoids. By applying the theorem and accounting for frictional drag effects at the surface, a drainage domain about 100 m in depth with a speed of 4 m s^{-1} at TVR is estimated. Measured with profiles at that location show quite good agreement in a sublayer although larger scale driving forces account for a complex structure of wind speed and direction above the 100 to 200 m layer. (JGB)

26295 (LA-UR—80-805) **Nocturnal drainage wind characteristics in two converging air sheds.** Gedayloo, T.; Clements, W.E.; Barr, S.; Archuleta, J.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800327—6). NTIS, PC A02/MF A01.

From 2. joint conference on applications of air pollution meteorology; New Orleans, LA, USA (24 Mar 1980).

During the short experimental period in the Grants Basin of Northeastern New Mexico a survey was conducted on the complex meteorology of this area. Emphasis was placed on the nocturnal drainage flow because of the potential hazards to the populated areas of Milan and Grants from the effluents of the uranium mining and milling operation in this area. This investigation has shown that the nocturnal drainage flow patterns agree with the winds predicted on the basis of the complex terrain of the area. Because of the surface cooling at night (over 25°C during summer and about 20°C during

winter), air from elevated surrounding areas flows to the low lying regions consequently setting up a nocturnal drainage flow. This regime exists over 60% of the time during summer months and over 65% of the time during winter months with a depth generally less than 200 m. In the San Mateo air shed the drainage flow is east northeast, and in the Ambrosia Lake air shed it is from northwest. The confluence of these two air flows contributes mainly to the drainage flow through the channel formed by La Ja Mesa and Mesa Montanosa. The analysis of data collected by the recording Flats Station confirms the prediction that although the area south of the channel region broadens considerably causing a reduction in flow speed, contributions from the southside of La Jara Mesa and Mesa Montanosa partly compensate for this reduction. The position of this recording station is 15 to 20 km from the populated towns of Milan and Grants. A drainage flow speed of approximately 2.2 m s^{-1} and the duration of over 11 hours as recorded by this station indicates that air from the San Mateo and Ambrosia Lake regions may be transported southwards to these population centers during a nocturnal period. In order to test this prediction, a series of multi-atmospheric tracer experiments were conducted in the Grants Basin.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25224, 25229, 25230, 25331, 25877, 25948, 26085, 26317, 26335, 26347, 26440, 26446

26296 (BNL—27804) **Time dependence of average regional sulfur oxide concentrations.** Kleinman, L.I.; Carney, T.A.; Meyers, R.E. (Brookhaven National Lab., Upton, NY (USA)). Mar 1980. Contract AC02-76CH00016. 7p. (CONF-800327—12). NTIS, PC A02/MF A01.

From 2. joint conference on applications of air pollution meteorology; New Orleans, LA, USA (24 Mar 1980).

The atmospheric burden of SO_2 and SO_4 in a large regional area has been calculated as a function of time during the July 1978 SURE intensive period. A formulism is developed in which a highly parameterized description of deposition and chemical conversion is combined with a realistic emissions inventory and with realistic trajectories as calculated with the BNL long-range air quality model, ARSOX. Temporal variations in the regional atmospheric burden are calculated as being due to variations in the advection of material through the region, with the pollutant being advected having a characteristic half-life for its formation and decay. The calculated atmospheric burdens are divided by a nominal mixing height to derive an average ground-level concentration. Comparison is made with the corresponding concentrations derived from SURE observations. The regions for which these comparisons have been made are in the Midwest and East and are similar in size ($\sim 5 \times 10^5$ KM^2) and location to areas commonly affected by regional sulfate episodes.

26297 (CONF-800602—4) **Analysis of coal-derived products and environmental systems by synchronous fluorescence and room temperature phosphorescence.** Vo-Dinh, T.; Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

Two simple room temperature techniques, synchronous fluorescence and phosphorescence, were utilized to determine the polynuclear aromatic (PNA) compounds in various complex systems including synthetic multicomponent mixtures and real-life samples such as workplace air particulate extracts and coal-derived samples. The results demonstrate that as many as a dozen PNA compounds can be identified and quantified by these two analytical methods.

26298 (DP-MS—79-51) **Use of helium-3 as a gas tracer for mesoscale meteorological studies.** Halverson, J.E.; Pendergast, M.M.; Boni, A.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 24p. Dep. NTIS, PC A02/MF A01.

Plans to use ^{3}He as a tracer in atmospheric diffusion studies are outlined. A specially designed static gas mass spectrometer will be used to measure ^{3}He/^{4}He abundance ratios in the atmospheric samples. Analysis of results of previous studies indicate that ^{3}He can be a useful tracer for plume releases at distances greater than 100 km. (JGB)

26299 (EPA—600/7-79-050e) **Proceedings of the third stationary source combustion symposium. Vol V. Addendum.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Feb 1979. 138p. (CONF-790338—(Vol.5)). NTIS.

From 3. EPA stationary source combustion symposium; San Francisco, CA, USA (5 Mar 1979).

The proceedings document the approximately 50 presentations made during the symposium, March 5-8, 1979, in San Francisco. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory-RTP, the symposium dealt with subjects relating both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources and to improving equipment efficiency. The symposium was in seven parts, and the proceedings are in five volumes: I. Utility, Industrial, Commercial, and Residential Systems; II. Advanced Processes and Special Topics; III. Stationary Engine and Industrial Process Combustion Systems; IV. Fundamental Combustion Research and Environmental Assessment; and V. Addendum. The symposium provided contractor, industrial, and government representatives with the latest information on EPA inhouse and contract combustion research projects relating to pollution control, with emphasis on reducing NOx while controlling other emissions and improving efficiency.

26300 (NTISUB/E/042—04) **EPA publications bibliography. Quarterly abstract bulletin, October-December 1979.** (National Technical Information Service, Springfield, VA (USA)). 1979. 444p. NTIS.

This bibliography contains citations, abstracts and author, corporate source, subject, contract, and title indexes for all US Environmental Protection Agency reports entered into the NTIS collection in the period October-December 1979. (ACR)

26301 (ORNL/EIS—108/V1) **Carbon cycles and climate: a selected bibliography.** Olson, J.S.; Allison, L.J.; Collier, B.N. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 42p. NTIS, PC A03/MF A01.

This partially annotated bibliography contains the first 1000 references from a computerized file of literature on the global ecological implications of carbon cycles and climatic changes. Many early citations originated from the Biogeochemical Ecological Information Center established at Oak Ridge National Laboratory in 1968 and from profiles of computerized files such as Government Research Abstracts (GRA) and Biological Abstracts (BA). Later citations have been extracted from the open literature through 1978 and early 1979, from government reports and impact statements, and from profiles of GRA, BA, and the Energy Data Base of the Department of Energy Technical Information Center, Oak Ridge, Tennessee. The subject categories covered by this bibliography may be divided into two main topics: carbon cycling and climate system analysis. Volume I contains an introduction and overview.

26302 (ORNL/EIS—108/V2) **Carbon cycles and climate: a selected bibliography.** Olson, J.S.; Allison, L.J.; Collier, B.N. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 256p. NTIS, PC A12/MF A01.

This partially annotated bibliography contains the first 1000 references from a computerized file of literature on the global ecological implications of carbon cycles and climatic changes. Many early citations originated from the Biogeochemical Ecological Information Center established at Oak Ridge National Laboratory in 1968 and from profiles of computerized files such as Government Research Abstracts (GRA) and Biological Abstracts (BA). Later citations have been extracted from the open literature through 1978 and early 1979, from government reports and impact statements, and from profiles of GRA, BA, and the Energy Data Base of the Department of Energy Technical Information Center, Oak Ridge, Tennessee. The subject categories covered by this bibliography may be divided into two main topics: carbon cycling and climate system analysis. Volume 2 contains an alphabetical (by author) listing of citations.

26303 (ORNL/EIS—108/V3) **Carbon cycles and climate: a selected bibliography.** Olson, J.S.; Allison, L.J.; Collier, B.N. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 184p. NTIS, PC A09/MF A01.

This partially annotated bibliography contains the first 1000 references from a computerized file of literature on the global ecological implications of carbon cycles and climatic changes. Many early citations originated from the Biogeochemical Ecological Information Center established at Oak Ridge National Laboratory in 1968 and from profiles of computerized files such as Government Research Abstracts (GRA) and Biological Abstracts (BA). Later citations have been extracted from the open literature through 1978 and early 1979, from government reports and impact statements, and from profiles of GRA, BA, and the Energy Data Base of the Department of Energy Technical Information Center, Oak Ridge, Tennessee. The subject categories covered by this bibliography may be divided into two main topics: carbon cycling and climate system analysis. Volume 3 provides indexes for author, organization (corporate authority), keywords (or free index terms), taxonomic category, subject category, Chemical Abstracts codes, Biological Abstracts codes (crosscode), and COSATI/Weekly Government Abstracts codes concentrated with permuted title words.

26304 (UCRL—51444-79) **Program report for FY 1979: Atmospheric and Geophysical Sciences Division of the Physics Department.** Knox, J.B.; Orphan, R.C. (eds.). (California Univ., Livermore

(USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 81p. NTIS, PC A05/MF A01.

The Atmospheric and Geophysical Sciences (G) Division continues to develop and validate modeling techniques for air quality assessments. The data developed by G Division are used by government officials to help them plan and implement energy programs. Our research includes the following varied areas: regional and local effects of atmospheric releases of toxic or radioactive materials; global climatic effects of accumulated atmospheric carbon dioxide resulting mainly from the increased use of fossil fuels; behavior of pollutants in areas of complex terrain or complex meteorological processes; evaluation of hazards from LNG spills; impact of fossil-fuel emissions, particularly sulfates and acid rain. These studies help the DOE to fulfill its goal of meeting our energy needs while at the same time ensuring public health, safety, and an acceptable environment quality.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25344, 25370, 26288, 26304, 26321, 26418

26305 (AD-A—077363/0) **Atmospheric 222Rn measurements at San Nicolas Island. Memorandum report.** Larson, R.E. (Naval Research Lab., Washington, DC (USA)). 13 Nov 1979. 7p. NTIS, PC A02/MF A01.

Radon (222) measurements showed that maritime air prevailed for four of the nine days of sampling from April 30 to May 10, 1978. There were, in addition, two days of small continental influence and three days of moderate continental influence. This period was in contrast to May 8 to 22, 1978 (CEWCOM-78) and November 17 to 21, 1979, where in the former, there were only two brief periods of maritime air, and in the latter only one sample was taken that was not continental.

26306 (ANL—79-65(Pt.2), pp 21-30) **Radioactivity in the furnace air-cleaning filter from a house with an unusually high level of airborne radon.** Rundo, J.; Essling, M.A.; Urnezis, P.W. 1979.

In Radiological and Environmental Research Division. Annual report.

The amounts of the three short-lived daughters of radon on the furnace air-cleaning filter from a house with a high level of radon were estimated to be 8.2, 33, and 38 kBq (0.22, 0.89, and 1.03 μCi) for ^{218}Po, ^{214}Pb, and ^{214}Bi, respectively, at the time of removal from the furnace. These data were used to calculate the airborne concentrations of the three, and the results indicated that about 70% of the daughters were lost to surfaces in the house and by impaction in the air ducts. The filter's content of ^{210}Pb was found to be 4.4 kBg (0.12 μCi); from this the average concentration of radon-producing filterable daughters during the time the furnace blower operated, was estimated to be 860 Bq m^{-3}. This indicated that there was no significant loss to surfaces or in air ducts. Possible reasons for the difference are given. The filter was also found to contain 1 kBq (27 nCi) of ^{212}Bi from the thorium series.

26307 (DP—1551) **Real time quality control of meteorological data used in SRP's emergency response system.** Pendergast, M.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). May 1980. Contract AC09-76SR00001. 18p. NTIS, PC A02/MF A01.

The Savannah River Laboratory's WIND minicomputer system allows quick and accurate assessment of an accidental release at the Savannah River Plant using data from eight meteorological towers. The accuracy of the assessment is largely determined by the accuracy of the meteorological data; therefore quality control is important in an emergency response system. Real-time quality control of this data will be added to the WIND system to automatically identify inaccurate data. Currently, the system averages the measurements from the towers to minimize the influence of inaccurate data being used in calculations. The computer code used in the real-time quality control has been previously used to identify inaccurate measurements from the archived tower data.

26308 (EGG—1183-1660) **Aerial radiological survey of the area surrounding the St. Lucie Power Plant, Fort Pierce, Florida.** Feimster, E.L. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Jun 1979. Contract AC08-76NVO1183. 14p. NTIS, PC A02/MF A01.

An airborne radiological survey of an 1100 km^2 area surrounding the St. Lucie Power Plant was conducted 1 to 8 March 1977. Detected radioisotopes and their associated gamma ray exposure rates were consistent with that expected from the normal background emitters. Count rates observed at 150 m altitude are converted to equivalent exposure rates at 1 m above the ground and are presented in the form of an isopleth map. Ground exposure rates measured with small portable instruments and soil sample analysis agreed with the airborne data. Geological data are presented in an isopleth map of rock and soil types. Also included is a brief description of the vegetation and terrain surrounding the site.

26309 (EGG—1183-1680) **Aerial radiological survey of the area surrounding the Feed Materials Production Center, Fernald, Ohio. Dates of surveys, August 1976/May-June 1977.** Feimster, E.L. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Jun 1979. Contract AC08-76NV01183. 27p. NTIS, PC A03/MF A01.

Two aerial radiological surveys to measure terrestrial gamma radiation were made over an area centered on the United States Department of Energy's Feed Materials Production Center in the city of Fernald, Ohio. The Center is operated by the National Lead Company of Ohio. Gamma ray data were collected from east-west flight lines at 90 m intervals over an area 25 km^2 centered on the plant site. The small Ohio towns of Shandon, Ross, and New Baltimore were surveyed from north-south flight lines at 300 m intervals. Processed data indicated that on-site radioactivity was due primarily to radionuclides currently being handled or processed at the Center. Off-site data showed the radioactivity to be due to naturally occurring radionuclides northeast and south of the site. If the northwest corner of the survey area an unusually high count rate region of airborne radon daughter activity was encountered. This was equivalent to approximately four times the normal background. However, the follow-up survey of 1977 showed this area to be within the background count rate level.

26310 (EGG—1183-1747) **Aerial radiological survey of the area surrounding the Chem-Nuclear Disposal Facility and Allied General Nuclear Services Facility, Barnwell, South Carolina.** (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Jun 1979. Contract AC08-76NV01183. 12p. NTIS, PC A02/MF A01.

An aerial radiological survey to measure terrestrial γ radiation was carried out over the Chem-Nuclear Disposal Facility and the Allied General Nuclear Services Facility located near Barnwell, South Carolina. At the time of the survey (November 1977) the nuclear fuel Facility had not begun operations and no radioactive materials were being processed. Gamma ray data were collected over an 8 km^2 area centered on the Facilities by flying east-west lines spaced 60 m apart. Processed data indicated that detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from normal background emitters, except at certain locations described in this report. Average exposure rates 1 m above the ground, as calculated from the aerial data, are presented in the form of an isopleth map. No ground sample data were taken at the time of the aerial survey.

26311 (EGG—1183-1756) **Aerial radiological survey of the area surrounding the UNC Recovery Systems Facility, Wood River Junction, Rhode Island. Date of survey: August 1979.** (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Dec 1979. Contract AC08-76NV01183. 13p. NTIS, PC A02/MF A01.

An aerial radiological survey to measure terrestrial gamma radiation was carried out over the UNC Recovery Systems facility located near Wood River Junction, Rhode Island. At the time of the survey (August 1979) materials were being processed at the facility. Gamma ray data were collected over a 3.63 km^2 area centered on the facility by flying north-south lines spaced 60 m apart. Processed data indicated that detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from normal background emitters, except at certain locations described in this report. Average exposure rates 1 m above the ground, as calculated from the aerial data, are presented in the form of an isopleth map. No ground sample data were taken at the time of the aerial survey.

26312 (EGG—1183-1760) **Graphic overview system for DOE's effluent and environmental monitoring programs.** Burson, Z.G.; Elle, D.R. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Mar 1980. Contract AC08-76NV01183. 33p. NTIS, PC A03/MF A01.

The Graphic Overview System is a compilation of photos, maps, overlays, and summary information of environmental programs and related data for each DOE site. The information consists of liquid and airborne effluent release points, on-site storage locations, monitoring locations, aerial survey results, population distributions, wind roses, and other related information. The relationships of different environmental programs are visualized through the use of colored overlays. Trends in monitoring data, effluent releases, and on-site storage data are also provided as a corollary to the graphic display of monitoring and release points. The results provide a working tool with which DOE management (headquarters and field offices) can place in proper perspective key aspects of all environmental programs and related data, and the resulting public impact of each DOE site.

26313 (ORNL—5452) **Radiological survey of the inactive uranium-mill tailings at Slick Rock, Colorado.** Haywood, F.F.; Perdue, P.T.; Chou, K.D.; Ellis, B.S. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 92p. NTIS, PC A05/MF A01.

Results of a radiological survey of two inactive mill sites near Slick Rock, Colorado, in April 1976 are presented. One mill, referred to in this report as North Continent (NC), was operated primarily for recovery of radium and vanadium and, only briefly, uranium. The Union Carbide Corporation (UCC) mill produced a uranium concentrate for processing elsewhere and, although low-level contamination with ^{226}Ra was widespread at this site, the concentration of this nuclide in tailings was much lower than at the NC site. The latter site also has an area with a high above-ground gamma dose rate (2700 μR/hr) and a high-surface ^{226}Ra concentration (5800 pCi/g). This area, which is believed to have been a liquid disposal location during plant operations, is contained within a fence. A solid disposal area outside the present fence contains miscellaneous contaminated debris. The estimated concentration of ^{226}Ra as a function of depth, based on gamma hole-logging data, is presented for 27 holes drilled at the two sites.

26314 (ORNL—5455) **Radiological survey of the inactive uranium-mill tailings at Rifle, Colorado.** Haywood, F.F.; Jacobs, D.J.; Ellis, B.S.; Hubbard, H.M. Jr.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 101p. NTIS, PC A06/MF A01.

Results of radiological surveys of two inactive uranium-mill sites near Rifle, Colorado, in May 1976 are presented. These sites are referred to as Old Rifle and New Rifle. The calculated ^{226}Ra inventory of the latter site is much higher than at the older mill location. Data on above-ground measurements of gamma exposure rates, surface and near-surface concentration of ^{226}Ra in soil and sediment samples, concentration of ^{226}Ra in water, calculated subsurface distribution of ^{226}Ra, and particulate radionuclide concentrations in air samples are given. The data serve to define the extent of contamination in the vicinity of the mill sites and their immediate surrounding areas with tailings particles. Results of these measurements were utilized as technical input for an engineering assessment of these two sites.

26315 (ORNL—5458) **Radiological survey of the inactive uranium-mill tailings at Ambrosia Lake, New Mexico.** Haywood, F.F.; Christian, D.J.; Ellis, B.S.; Hubbard, H.M. Jr.; Lorenzo, D.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 78p. NTIS, PC A05/MF A01.

The inactive uranium-mill tailings pile at Ambrosia Lake, New Mexico, contains approximately 1520 Ci of ^{226}Ra in 2.4 million metric tons of tailings covering an area of 43 hectares. All of the former mill buildings were intact and, at the time of this survey, several were in use. The tailings have not been stabilized, but the crusty surface is reported to be resistant to wind erosion. The average gamma-ray exposure rate 1 m above the tailings is 720 μR/h while the average rate in the former mill area is 150 μR/h. The adjacent area, between the mill site, ponds, and tailings pile, has an average exposure rate of 230 μR/h. Gamma radiation measurements outside these areas, as well as the results of analyses of surface or near-surface sediment and soil samples, show fairly wide dispersion of contamination around the site. The subsurface distribution of ^{226}Ra in 18 holes drilled at the site, calculated from gamma-ray monitoring data, is presented graphically and compared with measured concentrations in two holes.

26316 (UCRL—50007-79-2) **Hazards control progress report No. 58, April-September 1979.** Griffith, R.V. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Feb 1980. Contract W-7405-ENG-48. 45p. NTIS, PC A03/MF A01.

Progress is reported on research in the areas of radiation protection and industrial hygiene. Subject areas include: (1) basic computer programs for counting room automation; (2) a computing portable neutron spectrometer; (3) preliminary measurements of the neutron energy response of CR-39 carbonate plastic; (4) effect of high-expansion foam on self-1 contained breathing apparatuses; (5) permeation of organic solvents through glove samples; (6) determining neutron dose rates and 9-to-3 in. sphere ratios from a moderated 252Cf source in the LLL Calibration Facility; (7) application of the AERIN computer code to two americium inhalation exposures; and (8) air- and soil-sampling program at Site 300's high-explosive test bombers. (ACR)

26317 (Y/UB—14) **United States Department of Energy Paducah Gaseous Diffusion Plant. Environmental monitoring report, calendar year 1979.** (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 2 Jun 1980. Contract W-7405-ENG-26. 37p. NTIS, PC A03/MF A01.

Air, water, soil, and grass in the vicinity of the Paducah Gaseous Diffusion Plant were continuously or periodically sampled during 1979. Analyses for materials known to be in plant effluents were made to provide effluent control information and to determine compliance with applicable air and water quality standards. Stack emission tests determined that smelter operations were in compliance with Kentucky air pollution regulations. Low sulfur coal is burned in the steam plant to meet Kentucky emission limits for sulfur dioxide. Air analyses for radioactivity indicated concentrations at each offsite sampling station averaged less than 1% of the applicable Radioactivity Concentration Guide. Offsite analyses for fluorides in grass met the Kentucky Air Quality Requirements. All onsite and offsite airborne fluoride samples met the Kentucky one-week and one-month standards for gaseous HF. Soil samples were analyzed for uranium and showed no significant deviation from background. There was no detectable change in chemical, physical, or radioactive characteristics of either the Ohio river or ground water attributable to Paducah Gaseous Diffusion Plant operations.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

26318 **Effects of drying and air-dry storage of soils on their capacity for denitrification of nitrate.** Patten, D.K.; Bremner, J.M.; Blackmer, A.M. (Iowa State Univ., Ames). Contract EY-76-S-02-2530. *Soil Sci. Soc. Am. J.;* **44**: No. 1, 67-70(Jan 1980).

The effects of drying and air-dry storage of soils on their capacity for denitrification of nitrate were studied by determining the influence of these pretreatments on the ability of soils to reduce nitrate to gaseous forms of nitrogen (N_2, N_2O, and NO) when incubated anaerobically with nitrate for various times. It was found that drying of soils markedly increases their capacity for denitrification of nitrate under anaerobic conditions and that the effect observed increases as the temperature of drying is increased from 25° to 100°C. Partial drying of soils and storage of air-dried soils also lead to a significant increase in their ability to denitrify nitrate under anaerobic conditions. Determination of the CO_2 produced when field-moist, partly dried, air-dried, and air-dried and stored soils were incubated anaerobically with nitrate showed that production of CO_2 was very highly correlated with production of (N_2O + N_2)-N. This suggests that drying and air-dry storage of soils increase their capacity to denitrify nitrate under anaerobic conditions by increasing the amount of soil organic matter readily utilized by denitrifying microorganisms.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25331, 26297, 26300, 26301, 26302, 26303, 26347

26319 **Association of trace elements with iron oxides during rock weathering.** Koons, R.D.; Helmke, P.A.; Jackson, M.L. (Univ. of Wisconsin, Madison). Contract EY-76-S-02-1515. *Soil Sci. Soc. Am. J.;* **44**: No. 1, 155-159(Jan 1980).

The association of trace elements with Fe oxides during the early stages of rock weathering was determined by analysis of fresh diabase and granite rocks, their associated whole and size-separated saprolites, and goethite by neutron activation and X-ray fluorescence. The same elements are found to be associated with Fe oxides when the results are interpreted by analysis of correlation, by the distribution of elements in the various size fractions by the effects of removing free Fe oxides, and by direct analysis of geothite from the saprolite. The elements Co, Cr, Mn, Sc, Th, U, Zn, and the heavy rare-earth elements during the weathering of diabase, and As, Co, Cr, Sc, Th, U, Zn, and the heavy rare-earth elements during the weathering of granite are associated with Fe oxides. The concentrations of Mn are too low in this system to separate the effects of Mn oxides from those of Fe oxides.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 26312, 26317, 26319

SOIL

REFER ALSO TO CITATION(S) 25401, 25405, 25418, 25419, 25425, 25426, 25428, 26308, 26309, 26313, 26314, 26315

26320 (AD-A—077495/0) **Bikini scientific resurvey. Volume II. Report of the technical director. Annex IV. Supplement. Technical**

report. (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 50p. NTIS, PC A03/MF A01.

Contents: Radiochemical Analysis of Plutonium and Fission Products; and Soil Chemistry at Bikini.

26321 (ANL—79-65(Pt.2), pp 1-12) **Some measurements of radon and its daughters in houses.** Rundo, J.; Markun, F.; May, H.A.; Plondke, N.J.; Keefe, D.J. 1979.

In Radiological and Environmental Research Division. Annual report.

The bare soil in the unpaved crawl space of a house is the source of unusually high levels ($\geq$ 185 Bq m^{-3}) of radon in the air of some houses (46% of those investigated), although the radium content of the soil is normal ($\sim$ 40 Bq kg^{-1}). High concentrations can also be found in the air in the basement sump. Measurements made with an Environmental Working Level Monitor in two houses showed that the average annual concentration of radon daughters may be in the region of 0.01 WL.

26322 (ANL—79-65(Pt.2), pp 31-38) **Elevated radon levels in buildings: an investigation of potential sources in Region V arising from energy-conserving practices.** May, H.A. 1979.

In Radiological and Environmental Research Division. Annual report.

Some trends in single dwelling construction, and the resulting possibility of increased radiation exposure from radon progeny to the inhabitants, are identified. The number of such dwellings available and convenient for an ANL study is estimated. Preliminary measurements are reported.

26323 (ORNL/TM—7406) **Gamma exposure rates due to neutron activation of soil: site of Hood detonation, Operation Plumbbob.** Auxier, J.A.; Ohnesorge, W.F. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01.

This paper is the result of some recent discussions of exposure rates within the first few hours of the Hood detonation of the Plumbbob series due to neutron activation of soil. We estimated the exposure rates from 1/2 to 3 h after the detonation from ground zero to 1000 yards from ground zero. The area was assumed to be uncontaminated by fallout. Soil samples from the area of the Nevada Test Site at which the Hood device was detonated were sent to ORNL by Dr. John Malik of Los Alamos and by Mr. Gordon Jacks of the Nevada Test Site. These samples were irradiated at the DOSAR facility and the resulting activity analyzed. Calculations of exposure rates were then made based on the analyzed activity and the measured thermal neutron fluences at DOSAR and at the Hood Site.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 25232, 25235, 25313, 25330, 25334, 25335, 25402, 25406, 25407, 25421

REGULATIONS

REFER ALSO TO CITATION(S) 25286, 25444, 25961

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 25397, 25874

26324 (BNL—27636) **Nutrients, recycling, and biological populations in upwelling ecosystems.** Whitledge, T.E. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 46p. (CONF-800237—1). NTIS, PC A03/MF A01.

From International symposium on coastal upwelling; Los Angeles, CA, USA (4 Feb 1980).

Nutrient recycling has been studied in the upwelling areas of Baja California, Northwest Africa, and Peru. Regeneration by biological populations in these areas contributes significant quantities of recycled nitrogen which is utilized in productivity processes. Each area has a different combination of organisms which leads to differences in the relative contributions of zooplankton, nekton, or benthos to the nutrient cycles. Comparisons of ammonium regeneration rates of zooplankton and nekton-micronekton populations in the three upwelling areas show that zooplankton recycle relatively less nitrogen in the Baja California and Peru systems than nekton. In the Northwest Africa upwelling region, however, zooplankton, fish, and benthic inputs are all substantial. In recent years the Peruvian upwelling system has been altered with the decline of the anchoveta population and an increase in the importance of zooplankton in nutrient recycling. The distribution of recycled nitrogen (ammonium and urea) in transects across the shelf at 10°S and 15°S indicates that regeneration is relatively more important at 10°S in the region of the wide shelf. In both areas the distribution of ammonium and urea are not entirely coincident thereby indicating differences in their production and/or utilization.

26325 (COO—4941-2) **Fatty acid ecology of plankton communities. Progress report, May 1, 1979-April 30, 1980.** Jeffries, H.P. (Rhode Island Univ., Kingston (USA). Graduate School of Oceanography). Jan 1980. Contract AC02-78EV04941. 44p. NTIS, PC A03/MF A01.

The principal hypothesis addressed in this study states that community variability is related to fatty acid structure. As a test of this idea, the zooplankton in three regimes of increasing physical severity (Block Island Sound, Narragansett Bay and Green Hill Pond) are being compared. Measurements were made on the physical environment, on standing crop and on fatty acid composition in both the phytoplankton-microzooplankton and macrozooplankton. Fatty acid variation in these communities displays a unique trajectory in time at each location. Environmental change and biochemical variability are directly related. The resulting biochemical message is complex but apparently highly informative. Patterns of variation in some fatty acids are affected most strongly by physical environmental parameters whereas the variation of other fatty acids is more responsive to differences in species composition, diversity and food web relationships. Taken together, these two aspects of biochemical pattern appear to characterize complex species assemblages. The result offers a new strategem for convenient assessment of the ever changing state in a natural community.

26326 (DOE/EV/10259—T1) **Geographic analysis of thermal equilibria: a bioenergetic model for predicting thermal response of aquatic insect communities. Progress report, July 1, 1979-June 30, 1980.** Vannote, R.L.; Sweeney, B.W. (Academy of Natural Sciences, Avondale, PA (USA). Stroud Water Research Center). 1 Apr 1980. Contract AC02-79EV10259. 29p. NTIS, PC A03/MF A01.

This report summarizes the first 9 months of field and laboratory work to test our central hypothesis. Five river systems were selected for intensive studies on insect growth, metabolism, and fecundity as well as determination of community structure for distinct assemblages of insect species exploiting various trophic and habitat resources. Laboratory studies were initiated to test the relative importance of temperature and food quality on growth, size, and fecundity of insects. Our project is intended to test the hypothesis that population stability, within the geographic range of many stream species, reflects largely a dynamic equilibrium between temperature and individual growth, metabolism, reproductive potential, and generation time. We propose to delineate the significance of natural thermal variation by quantifying the bioenergetics, developmental dynamics, and spatial distribution of major representative groups of stream insects throughout their geographic range.

26327 (EPRI-WS—78-151, pp 3.45-3.50) **Synthesis and analysis of ecological information from cooling impoundments: perspectives.** Becker, C.D. (Battelle Pacific Northwest Labs., Richland, WA). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A literature review and a discussion are presented of the assessment program undertaken to examine the ecological effects of the once-through cooling mode of power plant operation on small aquatic ecosystems represented by cooling impoundments. Objectives were to synthesize and analyze existing ecological information and data and extrapolate the conclusions to other ecosystems. (DAD)

26328 (EPRI-WS—78-151, pp 3.69-3.84) **Assessment methodology for new cooling lakes.** Lorenzen, M.W.; Ginn, T.C. (Tetra Tech, Inc., Lafayette, CA). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A methodology for assessment of new cooling lakes was developed. The methodology is directed at utilities' requirements to demonstrate benefits. The major issues addressed will be water consumption, water quality, fish production, and multipurpose development. (DAD)

26329 **Flushing of the continental shelf south of Cape Hatteras by the Gulf Stream.** Blanton, J.O. (Skidaway Inst. of Oceanography, Savannah GA); Pietrafesa, L.J. Contract EY-76-S-09-0902. *Geophys. Res. Lett.;* 5: No. 6, 495-498(Jun 1978).

Onslow Bay, an embayment south of Cape Hatteras in the South Atlantic Bight, responds to discrete southwestward and northeastward wind stress events. Occasionally, dramatic onshore-off-

shore flow cycles occur that appear tirggered by a large-scale disturbance probably originating in the Gulf Stream. Winds and offshore disturbances drive a well-defined circulation pattern from which it is estimated that Onslow Bay is flushed every 2 months. This agrees quite well with a freshwater removal rate of about 2.7 months and a Gulf Stream entrainment removal rate of 3 months.

26330 (SRO—1025-T1) **Data report No. 1. Oceanographic and meteorological data 15 km off the coast of Georgia.** Blanton, J.O.; Bailey, L.L.; Chandler, W.S.; Hayes, D.W.; Dicks, A.S.; Parnelle, J.K.; Shugart, P.D. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.; Skidaway Inst. of Oceanography, Savannah, GA (USA)). [nd]. Contract EY-77-S-09-1025. 58p. NTIS, PC A04/MF A01.

The emphasis of many oceanographic studies has shifted to areas closer to the shore because these areas are increasingly being used for recreation and resource development. The waste from coastal nuclear and fossil power plants and a myriad of other energy related activity in the coastal zone is seen by many to conflict with man's use of this zone as a recreational and food resource. Thus, the data described in this report have been collected in order to attain an understanding of the characteristics of coastal currents. Data collected are hourly readings of wind, temperature, barometric pressure, and ocean currents.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25222, 25223, 25233, 25331, 25332, 25873, 26297, 26300, 26301, 26302, 26303, 26317, 26327, 26347

26331 (AD-A—077664/1) **Surface oil displacement by US Coast Guard 82-foot cutters. Final report, December 1977-February 1978.** Kraus, S.P.; Tennant, R.W.; Hansen, C. (California Univ., Santa Barbara (USA). Geography Remote Sensing Unit). Jan 1979. Contract N62583-78-M-R132. 83p. NTIS, PC A05/MF A01.

The U. S. Navy, in cooperation with the U. S. Coast Guard, is conducting design and feasibility studies for a portable oil sorbent spreader and retriever for use aboard military and commercial vessels-of-opportunity during oil spill clean up operations. As part of this program, the U. S. Navy's Civil Engineering Laboratory (CEL), Port Hueneme, California contracted with the Geography Remote Sensing Unit (GRSU), University of California, Santa Barbara to provide field support and data analysis services in conjunction with sea tests to determine the effects of vessels on surface oil slicks. A total of four sea truth data acquisition cruises were conducted through natural oil seeps in the Santa Barbara Channel, California between December 1977 and February 1978. Coast Guard 82-foot patrol boats served as representative vessels of opportunity for the tests. This report describes the data collection program associated with the sea tests and the results of our analysis of field data.

26332 (ANL—78-65(Pt.3), pp 96-99) **Tin in the waters, sediments, and tributaries of Lake Michigan's southern basin: a preliminary study.** Tisue, T.; Seils, C.A. 1978.

In Radiological and Environmental Research Division: ecology. Annual report, January-December 1978.

Progress is reported in research on the use of ammonium pyrollidine-dithiocarbomate (APDC) as a reagent for concentrating trace elements from natural waters prior to their determination by x-ray fluorescence spectrometry. Tin is among the elments to which this procedure proved applicable in Lake Michigan. Results for both surface waters and the southern basin's two major tributaries are tabulated. Although sparse, the data indicate higher Sn concentrations in late autumn river runoff than in samples taken in the spring, and higher levels in coastal samples (station 5) than those taken further offshort (stations 18 and 19). Sediment analyses indicated a sharp inrease in the Sn content in the more recent deposits. (JGB)

26333 (BNL—51074) **Limnological aspects of acid precipitation.** Hendrey, G.R. (ed.). (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract AC02-76CH00016. 54p. NTIS, PC A04/MF A01.

Lakes and streams in parts of Norway, Sweden, Canada, and the United States are being severely impacted by acidic precipitation. Scientists meeting at Sagamore, New York, agreed that this is the most serious limnological problem today. The factor responsible for determining the sensitivity of surface waters to acidification is alkalinity derived by weathering of soils and bedrock in the watershed. Acidification, defined as a reduction in alkalinity, can be quantified if preacidification alkalinity data exist, but often they do not. Data on pH and Ca from surface waters in areas not affected by acid precipitation were compared to similar data from areas which receive precipitation with a weighted average hydrogen ion concentration of pH < 4.6. A semiquantitative estimation of surface water acidification can be made for lakes and streams, where earlier chemistry data are lacking, based on this analysis of pH and Ca data. Biological responses to acidification range from a reduction in numbers of species of algae and zooplankton to complete elimination of all fish life. Major biological processes such as primary production and decomposition may be altered leading to an accumulation of plant material and organic debris within lakes and streams. Increased concentrations of aluminum from the $\mu g/l$ to mg/l range have been found at levels shown to be toxic to fish. These elevated levels apparently result from the exchange of H^+ and Al in the watershed. There also appears to be a relationship between lake acidification and the accumulation of mercury in fish. Problems of aluminum analysis received detailed attention, and watershed mass balances, comparative watershed studies, whole lake manipulations, synoptic surveys, and the liming of acidified waters were discussed. A priority-rated list of recommendations for research was presented.

26334 (CONF-800602—3) **DUVAS: an industrial hygiene monitor for PNA vapors.** Hawthorne, A.R.; Metcalfe, C.E. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

The design, development, and evaluation of a field-portable derivative uv-absorption spectrometer (DUVAS) for monitoring vapors from volatile aromatic compounds is described. The microcomputer-controlled instrument is capable of sensitive and selective multicomponent measurement of one- or two-ring aromatic compounds in real time. DUVAS is useful as an industrial hygiene tool both for area monitoring and for leak detection. Examples are given of field monitoring and laboratory evaluation of the prototype instrument.

26335 (DOE/EV/04581—1) **Investigation of the atmospheric and surface ocean pCO_2 in the Indian Ocean. Final technical report.** Takahaski, T. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). 1979. Contract AC02-77EV04581. 16p. NTIS, PC A02/MF A01.

The results of measurements for the concentration of CO_2 in the marine air and the partial pressure of CO_2 (pCO_2) in the surface ocean water obtained during the Geosecs Expedition in the north and south Indian Oceans, December 1977 through April 1978 are summarized. The area studied covers 13°N to 64°S in latitudes and 55°E to 115°E in longitudes. It has been found that the atmospheric CO_2 concentration in the southern hemisphere south of 15°S is remarkably constant at 334 +- ppM (expressed as mole fraction of CO_2 in dry air) throughout the period of this investigation. The CO_2 concentration in the northern hemisphere from the equator to 13°N exceeds that in the southern hemisphere by up to 5 ppM. The Inter-Tropical Convergence Zone (ITCZ) appears to represent a transition zone for the atmosphere CO_2 distribution. The surface water pCO_2 values in the Indian Ocean range from 300 microatm. to 360 microatm. The highest values were observed in the Arabian Sea, and appear to be due to the low alkalinity water flowing out of the Red Sea. The Indian equatorial water has a maximum pCO_2 value of about 335 microatm., which is about 10 microatm. (or 3%) greater than that in the atmosphere. The Indian Ocean data were combined with those previously obtained in the Pacific and Atlantic Oceans to yield a global mean pCO_2 value for the surface ocean water. It is found that the global mean pCO_2 for the world oceans is 10 +- 8 microatm. lower than the mean atmospheric pCO_2 value. This indicates that the net transfer rate of CO_2 from the atmosphere to the oceans corresponds to 50 (+-40)% of the industrial CO_2 production rate.

26336 (ORNL/TM—5865/V2) **Experimental Engineering Section semiannual progress report, March 1-August 31, 1976. Volume 2. Biotechnology and environmental programs.** Pitt, W.W. Jr.; Mrochek, J.E. (comps.). (Oak Ridge National Lab., TN (USA)). Mar 1978. Contract W-7405-ENG-26. 261p. NTIS, PC A12/MF A01.

This volume contains the progress report of the biotechnology and environmental programs in the Experimental Engineering Section of the Chemical Technology Division. Research efforts in these programs during this report period have been in five areas: (1) environmental research; (2) centrifugal analyzer development; (3) advanced analytical systems development; (4) bioengineering research; and (5) bioengineering development. Summaries of these programmatic areas are contained in Volume I.

26337 (ORNL/TM—6118) **Continuous environmental monitoring for aqueous effluents.** Pitt, W.W. Jr.; Jones, G. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 26p. NTIS, PC A03/MF A01.

An aquatic environmental monitor has been developed that will continuously monitor aqueous waste streams from coal processing plants. The monitor contains three different instruments: a continuous chemical oxygen demand monitor and two continuous-flow fluorometers with different excitation-emission characteristics. A prototype instrument was fabricated and evaluated for several different applications. The details of the instrument design and results of its evaluation are presented in this report.

26338 (UCID—17744-80-2) **Chemical effluents in surface waters from nuclear power plants. Quarterly progress report.** Harrison, F.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 9p. NTIS, PC A02/MF A01.

Field surveys were conducted at the Surry, Salem, and H.B. Robinson Nuclear Power Stations in May 1980. Analytical results available to date indicate copper concentrations are lower than those observed earlier. Experiments to assess the transport of copper across sediment-water interfaces were initiated. Results from a preliminary experiment show that gradients in the sediment layer and water column are established by 2 days. Experiments with sediment and water collected from the farm pond at Fort St. Vrain Nuclear Power Station are underway.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 26312, 26317

WATER

REFER ALSO TO CITATION(S) 25417, 25425, 26314, 26403

26339 (AD-A—077489/3) **Bikini scientific resurvey. Volume I. Operations. Technical report.** (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 134p. NTIS, PC A07/MF A01.

Contents: Origin of the BIKINI SCIENTIFIC RESURVEY; Authorization of the BIKINI SCIENTIFIC RESURVEY; Mission of the BIKINI SCIENTIFIC RESURVEY; Task Force Organization; Staff Organization; Procurement of Personnel; Scientific Group Organization; Procurement of Equipment; and Early Planning.

26340 (AD-A—077490/1) **Bikini scientific resurvey. Volume II. Report of the technical director. Technical report.** (Defense Atomic Support Agency, Washington, DC (USA)). Dec 1947. 124p. NTIS, PC A06/MF A01.

Contents: Island and Reef Geology; Submarine Geology; Drilling Operations; Radiobiology Studies; Reef and Lagoon Fishes; Pelagic Fishes; Taxonomy and Teratology of Fishes; Invertebrate Embryology; Vertebrate Embryology; Reef and Lagoon Algae; Chemical Effects of Organisms Upon Sea Water; The Insect Population; Marine Invertebrates; Land Animals; Plankton Studies; Counter-Room Activities; Radiochemical Analyses; Soils Chemistry; Low-Level Radiation Studies; Army Engineering Studies; Aerological Data; Bacteriological Investigations; Radiological Safety; Radiological Health; Technical Director's Summary.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 26340

26341 **Concentrations and temporal variations of ^{210}Po, ^{210}Pb, and Al in the surf zone ecosystem of Copalis Beach, Washington.** Bennett, J.T.; Carpenter, R. (Univ. of Washington, Seattle). *Estuarine Coastal Mar. Sci.;* **8**: 127-140(1979).

Surf diatoms monitored during a 21-month period at Copalis Beach, Washington, contained elevated concentrations of Al, ^{210}Pb, and supported ^{210}Po compared to net phytoplankton from Washington coastal waters and Puget Sound. Aluminum concentrations of several percent dry weight found in the surf diatoms were not a reflection of contamination by discrete inorganic particulate matter but were the result of a natural coating of clay-sized particles on Chaetoceros armatum, the predominant diatom in the surfblooms. A high correlation between Al and ^{210}Pb in the surf diatoms suggests ^{210}Pb and supported ^{210}Po were also associated with the clay-sized particles. During fall through spring, the unsupported ^{210}Po concentrations in the surf diatoms were correlated with the input of ^{210}Po by precipitation. A summer maximum in unsupported ^{210}Po concentrations in the surf diatoms may reflect upwelling that causes higher dissolved ^{210}Po concentrations in the summer surf relative to those of late spring and early fall. The consumers of the surf diatoms exhibited larger ^{210}Po-activity-to-^{210}Pb-activity ratios than their food, indicating ^{210}Po was preferentially accumulated in the higher trophic level.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25865, 25873, 25875, 26327, 26328, 26427, 26428, 26429, 26430, 26431, 26432, 26433, 26434, 26435

26342 (EPRI-WS—78-151, pp 3.23-3.44) **Methodology for evaluation of multiple power plant cooling system effects.** Lorenzen, M.W.; Ginn, T.C.; Bowie, G.; Grieb, T.; Zison, S. (Tetra Tech, Inc., Lafayette, CA). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A methodology consisting of a set of procedures, analytical relationships, and models to be used to assess the integrated effects of multiple power plant operation is described. The four volumes documenting the methodology include the following: Vol. I - General Description and Screening; Vol. II - Technical Basis of Computations; Vol. III - Data Requirements; and Vol. IV - User's Guide to Model Operation. (DAD)

26343 (EPRI-WS—78-151, pp 3.95-3.104) **Developing an expanded cooling system data base to include environmental descriptors.** Fava, J.A. (Ecological Analysts, Inc., Towson, MD). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The development of a comprehensive, computerized cooling system data base is discussed. The data base consists of environmental descriptors interrelated in a biological framework and a statistical applications package that will provide a means for effective analyses of system interactions and site-by-site comparisons. (DAD)

26344 (EPRI-WS—78-151, pp 3.106-3.108) **Thermal effects: real world state of the art.** Brooks, R.H. (Tennessee Valley Authority, Muscle Shoals, AL). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The problems facing scientists today who recognize that environmental restrictions are being compromised by economic factors and political expediencies are discussed. The author reminds his listeners to quickly acquire a state of the art so they can make timely and specific recommendations to regulatory agencies. (DAD)

26345 (EPRI-WS—78-151, pp 3.109-3.112) **Introduction to the UWAG review.** Pease, T.E. (Lawler, Matusky and Skelly Engineers, Pearl River, NY). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A study plan is described whose objectives are as follows: (1) to summarize methods currently applied to measure ecological effects of power plants with once-through cooling systems; and (2) to summarize the type and extent of temporal and spatial effects observed in these studies. This study was submitted to the Environmental Protection Agency (EPA) as input to new effluent limitations guidelines. (DAD)

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 25233, 25398

26346 **An analysis of water resources constraints on power plant siting in the mid-atlantic states.** Hobbs, B.F.; Meier, P.M. (US Brookhaven Natl Lab, NY). *Water Resour. Bull.;* **15**: No. 6, 1666-1676(Dec 1979).

Expansion of the electric power generation system in the Pennsylvania-New Jersey-Maryland power pool will impact and be constrained by inland water availability. A power plant siting model is described. The use of evaporative cooling towers for coastal power plants and public acceptability of low flow augmentation reservoirs are reviewed. Under any scenario, the impact of electric power generation on water resources is expected to be severe. (5 maps, 21 references, 2 tables)

REGULATIONS

REFER ALSO TO CITATION(S) 26344

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 25298, 25430, 25955, 25956, 25959, 25962, 25963, 25964, 25965, 25968, 25969, 26301, 26302, 26303

26347 (CONF-7910158—1) **Prospect of a global warming and studies of its societal impacts.** Kellogg, W.W. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA); National Center for At-

mospheric Research, Boulder, CO (USA)). 1979. Contract AC02-79EV10281. 16p. NTIS, PC A02/MF A01.

From 7. global modeling conference; Laxenburg, Austria (2 Oct 1979).

It is now generally accepted in the climatological community that a significant climate change will take place in the near future as a result of the continued burning of fossil fuel. This paper attempts to outline the major components of the program that will need to be undertaken to assess the economic and societal adjustments resulting from climatic change. (ACR)

26348 (COO—4575-1) **Environmentally-acceptable fossil energy site evaluation and selection: methodology and user's guide. Volume 1.** Northrop, G.M. (Center for the Environment and Man, Inc., Hartford, CT (USA)). Feb 1980. Contract EY-77-C-02-4575. 212p. (CEM—4231-625). NTIS, PC A10/MF A01.

This report is designed to facilitate assessments of environmental and socioeconomic impacts of fossil energy conversion facilities which might be implemented at potential sites. The discussion of methodology and the User's Guide contained herein are presented in a format that assumes the reader is not an energy technologist. Indeed, this methodology is meant for application by almost anyone with an interest in a potential fossil energy development - planners, citizen groups, government officials, and members of industry. It may also be of instructional value. The methodology is called: Site Evaluation for Energy Conversion Systems (SELECS) and is organized in three levels of increasing sophistication. Only the least complicated version - the Level 1 SELECS - is presented in this document. As stated above, it has been expressly designed to enable just about anyone to participate in evaluating the potential impacts of a proposed energy conversion facility. To accomplish this objective, the Level 1 calculations have been restricted to ones which can be performed by hand in about one working day. Data collection and report preparation may bring the total effort required for a first or one-time application to two to three weeks. If repeated applications are made in the same general region, the assembling of data for a different site or energy conversion technology will probably take much less time.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 25960, 25961, 25962, 25963, 25964, 25965, 25966, 25967, 25968, 25969, 25970, 25971, 25976

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 25874, 26452

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 26325, 26336, 26367, 26374, 26376, 26380, 26382, 26385, 26386, 26397, 26399, 26441, 26443, 26448, 26450, 26451, 26452, 26453, 26454

26349 (CONF-7807102—1) **Species comparison of protein synthesis accuracy.** Hirsch, G.P.; Popp, R.A.; Francis, M.C.; Bradshaw, B.S.; Bailiff, E.G. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

From Given Institute Pathobiology conference; Aspen, CO, USA (Jul 1978).

An important force in evolutionary selection may be informational efficiency, which results in a balance between the energy expended to maintain a high level of fidelity and the energy lost from errors or mutations in the production of defective offspring. The accuracy of DNA replication may be limited by the average accuracy of protein synthesis if the major source of enzymes which make copying errors are those that contain errors resulting from the processes of transcription and translation. Since many gene products are involved in transcription and translation the frequency of mutations which might affect protein fidelity is much higher than those affecting DNA copying. Species comparisons were made of the accuracy of protein synthesis to determine if the requirements for accurate protein synthesis were more stringent for long lived mammals. Using the incorporation of isoleucine in hemoglobin chains which contain no genetically coded isoleucine as a test of protein synthesis fidelity no correlation with lifespan was found among rabbit, marmoset, cow, pig, and human protein synthesis fidelity. The purfication techniques required to prepare highly purified protein for analysis and the criteria for purity are described.

26350 Isolation and characterization of the pigment-protein complexes of Rhodopseudomonas sphaeroides by lithium dodecyl sulfate/polyacrylamide gel electrophoresis. Broglie, R.M. (Rutgers Univ., New Brunswick, NJ); Hunter, C.N.; Delepelaire, P.; Niederman, R.A.; Chua, N.H.; Clayton, R.K. *Proc. Natl. Acad. Sci. U.S.A.;* **77**: No. 1, 87-91(Jan 1980).

When purified photosynthetic membranes from Rhodopseudomonas sphaeroides were treated with lithium dodecyl sulfate and subjected to polyacrylamide gel electrophoresis at 4°C, up to 11 pigment-protein complexes were resolved. Absorption spectra revealed that the smallest complex contained reaction center pigments and the others contained the antenna components B850 and B875 in various proportions. Of these antenna complexes, the largest was almost entirely B850 and the smallest contained only B875. After solubilization at 100°C and electrophoresis on polyacrylamide gradient gels, the B850 complex gave rise to two polypeptide components migrating with apparent M/sub r/ of 10,000 and 8000, whereas with the B875 complex, two components were observed with apparent M/sub r/ of 12,000 and 8000. The reaction center complex gave rise to only the 24 and 21 kilodalton polypeptide subunits. Fluorescence emission spectra showed maxima at 872 and 902 nm for B850 and B875, respectively. Analyses of bacteriochlorophyll a and carotenoids indicated that, in the B875 complex, two molecules of each of these pigments are associated with the two polypeptides. The associations of B850 and B875 in large and small complexes obtained by lithium dodecyl sulfate treatment are consistent with models of their organization within the membrane.

26351 Reaction of copper-zinc superoxide dismutase with diethyldithiocarbamate. Misra, H.P. (Univ. of California, Davis). Contract DE-AM03-763F00472. *J. Biol. Chem.;* **254**: No. 22, 11623-11628(25 Nov 1979).

Diethyldithiocarbamate reacted with superoxide dismutase from bovine erythrocytes. Changes in both optical and esr spectra, which accompanied this reaction, indicated involvement of the Cu(II). The reaction was accelerated by raising the concentrations of the reactants, elevating the temperature, and lowering the pH, in the range 10.2 to 5.5, and it was independent of the presence of oxygen. During the first phase of this reaction the Cu(II).diethyldithiocarbamate complex remained bound to the enzyme and the catalytic activity did not diminish. There followed a second and slower process which was accompanied by the appearance of colloidal Cu(II).chelate complex and by a loss of activity which could be restored by the addition of $CuSO_4$. All of the observations are accommodated by a model in which 1 diethyldithiocarbamate molecule reacts/copper center, with retention of activity, in Phase I, while a second diethyldithiocarbamate displaces the copper, with a loss of activity, in Phase II.

26352 Coordinated modulation of albumin synthesis and mRNA levels in cultured hepatoma cells by hydrocortisone and cyclic AMP analogs. Brown, P.C.; Papaconstantinou, J. (Univ. of Tennessee, Oak Ridge). Contract W-7405-ENG-26. *J. Biol. Chem.;* **254**: No. 19, 9379-9384(10 Oct 1979).

The treatment of Hepa-2 cells, a permanent mouse hepatoma cell line, for 72 h with hydrocortisone (10^{-6} M), $N^6,O^{2'}$-dibutyryl cyclic AMP (10^{-3} M), or 8-bromo cyclic AMP(10^{-3} M) results in a 2-, 3-, or 4-fold increase, respectively, in rates of synthesis and secretion of mouse serum albumin. Simultaneous treatment with hydrocortisone and $N^6,O^{2'}$-dibutyryl cyclic AMP results in a 10-fold stimulation in these parameters, an effect that is significantly more than additive for the two compounds tested. The number of albumin mRNA sequences, determined by hybridization of total cell RNA to albumin complementary DNA, was increased in direct proportion to the increases in albumin synthesis in all experiments. The relative rate of albumin synthesis approaches in vivo levels in cells treated simultaneously with hydrocortisone and $N^6,O^{2'}$-dibutyryl cyclic AMP. We propose that these factors may be necessary to maintain the maximal level of differentiated function in the continuous culture of Hepa-2 cells.

26353 Thrombocytin, a serine protease from Bothrops atrox venom. 1. Purification and characterization of the enzyme. Kirby, E.P. (Temple Univ. Health Sciences Center, Philadelphia, PA); Niewiarowski, S.; Stocker, K.; Kettner, C.; Shaw, E.; Brudzynsi, T.M. *Biochemistry;* **18**: No. 16, 3564-3570(7 Aug 1979).

Thrombocytin, a platelet-activating enzyme from Bothrops atrox venom, has been purified to homogeneity by precipitation with sodium salicylate and chromatography on heparin-agarose. Thrombocytin is a single-chain glycoprotein with a molecular weight of 36,000 which contains 5.6% carbohydrate. It causes platelet aggregation, release of platelet serotonin, and activation of factor XIII. The most sensitive substrate for the amidolytic activity of thrombocytin was Tos-Gly-Pro-Arg-p-nitroanilide hydrochloride. The activity of thrombocytin on this substrate and on platelets was inhibited by diisopropyl fluorophosphate (DFP), soybean trypsin inhibitor,

and several arginine chloromethyl ketones. Active site titration with nitrophenyl guanidinobenzoate demonstrated that approximately 86% of the preparation was in the active form. These experiments demonstrate the presence of serine and histidine in the active site of thrombocytin and suggest that thrombocytin is a classical serine protease with a platelet-activating activity similar to thrombin.

26354 Time-resolved resonance Raman characterization of the bO_{640} intermediate of bacteriorhodopsin. Reprotonation of the Schiff base. Terner, J.; Hsieh, C.L.; Burns, A.R.; El-Sayed, M.A. (Univ. of California, Los Angeles). *Biochemistry;* **18**: No. 16, 3629-3634(7 Aug 1979).

The resonance Raman spectrum of photolyzed bacteriorhodopsin under conditions known to increase the concentration of the bO_{640} intermediate in both H_2O and D_2O is presented. By use of computer subtraction techniques and a knowledge of the Raman spectra of the unphotolyzed bacteriorhodopsin as well as the other intermediates in the cycle, a qualitative spectrum of bO_{640} is determined. The shift of a band at 1630 cm^{-1} in H_2O to 1616 cm^{-1} in D_2O suggests that the Schiff base of bO_{640} is protonated. Additional bands at 947, 965, and 992 cm^{-1} that appear only in D_2O suspensions confirm that a proton is coupled to the retinal chromophore of bO_{640}. The reprotonation of the Schiff base thus occurs during the bM_{412} to bO_{640} step. The fingerprint region, sensitive to the isomeric configuration of the retinal chromophore of bO_{640}, is dissimilar to the fingerprint regions of published model compounds and other forms of bacteriorhodopsin.

26355 Rapid method for separating small vesicles from suspension. Rosier, R.N.; Gunter, T.E.; Tucker, D.A.; Gunter, K.K. (Univ. of Rochester, New York). *Anal. Biochem.;* **96**: No. 2, 384-390(15 Jul 1979).

Techniques for rapidly aggregating suspensions of small vesicles made either of natural biological membrane or of phospholipid or phospholipid-protein mixtures by addition of one of the basic polypeptides, polylysine or protamine, have been investigated. Either filtration or centrifugation may be used to rapidly (15 to 30 s) and completely (over 98%) separate the vesicular aggregate from the suspending medium. At low values of the polylysine-to-vesicle weight ratio, aggregation is observed to increase with increasing polylysine concentration. At high values of this same ratio, aggregation decreases with increasing polylysine concentration. With protamine, like polylysine, aggregation increases with protamine concentration at low values of the weight ratio. At high values of the ratio, aggregation induced by protamine does not rapidly decrease with increasing protamine concentration as it does with polylysine. Explanations are given for these observations. While leakage induced by polylysine may be troublesome under some conditions with phospholipid vesicles or reconstituted systems, protamine aggregation has been found to induce much less leakage than polylysine aggregation. The leakage rate induced by protamine was not found to be significantly different from the control leakage rate for the first few minutes after addition of protamine under any of the conditions tested. Since this provides ample time for filtration, the protamine aggregation - filtration technique seems to be the method of choice for separation of many types of small vesicles from the suspending medium. It combines the advantages of rapid separation, complete separation, low rate of vesicle leakage, and versatility in being able to separate the vesicles from uncharged molecular components such as sugars where ion-exchange techniques will not work (1), as well as from ionic components. Low cost and simplicity are further advantages of the technique.

26356 Inclusion complexes of poly-β-cyclodextrin: a model for pressure effects upon ligand-protein complexes. Torgerson, P.M.; Drickamer, H.G.; Weber, G. (Univ. of Illinois, Urbana). *Biochemistry;* **18**: No. 14, 3079-3083(10 Jul 1979).

Certain protein-ligand complexes are destabilized by application of pressures of the order of 5 to 10 kbar while others are stabilized. This divergent behavior is attributed to differences in compressibility of the protein binding sites. Pressure-stabilized binding is thought by us to be characteristic of soft binding sites, sites in which rotation about backbone bonds permits reduction of the site dimensions under pressure. In contradistinction, hard binding sites do not decrease their size when pressure is applied. As a model for this latter kind we have measured the changes in equilibrium with pressure of complexes of poly-β-cyclodextrin with two fluorescent probes: 8-anilinonaphthalene-1-sulfonate and 6-propionyl-2-(dimethylamino)naphthalene. The standard volume change upon formation of the complexes at 1 atm is similar in both (+9.3 mL/mol), and as expected the incompressibility of the cyclodextrin rings results in a site from which the probes are dissociated by pressure. On the assmption of incompressibility of the binding site, the experimental data permit the calculation of the pressure vs volume curves (compressibility curves) for the probes molecularly dispersed in water. These curves are in broad agreement with those of liquid aliphatic and aromatic hydrocarbons in the low-pressure range (1 to 4 kbar) but indicate a reduced compressibility at the higher pressures. Considerations of relative compressibility offer a quantitative alternative to the usual qualitative discussion of the effects of high pressures upon proteins in terms of the participation of hydrophobic and other bonds.

26357 Analytical techniques for cell fractions. XXV. Concentration and two-dimensional electrophoretic analysis of human urinary proteins. Anderson, N.G.; Anderson, N.L.; Tollaksen, S.L.; Hahn, H.; Giere, F.; Edwards, J. (Argonne National Lab., IL). Contract W-31-109-ENG-38. *Anal. Biochem.;* **95**: No. 1, 48-61(May 1979).

Due to the experimental and diagnostic possibilities found in the analysis of human urinary proteins, the authors have distinguished eight classes of protein in urine and initial studies for the development of clinical analysis. The authors discuss two methods for the concentrating of urinary proteins for analysis by high resolution two-dimensional electrophoresis.

26358 Error induction and correction by mutant and wild type T4 DNA polymerases. Clayton, L.K. (Univ. of Southern California, Los Angeles); Goodman, M.F.; Branscomb, E.W.; Galas, D.J. *J. Biol. Chem.;* **254**: No. 6, 1902-1912(25 Mar 1979).

The fidelity of DNA synthesis as determined by misincorporation of the base analogue 2-aminopurine in competition with adenine has been measured as a function of deoxynucleoside triphosphate substrate concentrations using purified mutator (L56), antimutator (L141), and wild type (T4D) T4 DNA polymerases. Although the rates of both incorporation and turnover of aminopurine and adenine decrease as substrate concentrations are decreased, the ratio of turnover/polymerase activity is increased. The misincorporation of aminopurine decreases with decreasing substrate concentrations such that all three enzymes approach nearly identical misincorporation frequencies at the lowest substrate concentration. The increased accuracy of DNA synthesis corresponds to conditions producing a high nuclease/polymerase ratio. The misinsertion frequency for aminopurine is independent of substrate concentrations and enzyme phenotype; therefore, the increased accuracy of DNA synthesis is shown to be a result of increased nuclease activity and not increased polymerase or nuclease specificity. The data are analyzed in terms of a kinetic model of DNA polymerase accuracy which proposes that discrimination in nucleotide insertion and removal is based on the free energy difference between matched and mismatched base pairs. A value of 1.1 kcal/mol free energy difference, ΔG, between adenine: thymine an aminopurine:thymine base pairs is predicted by model analysis. An independent estimate of this free energy difference also gives a value of 1.1 kcal/mol. It is shown that the aminopurine misinsertion frequency for an enzyme having either extremely low 3′-exonuclease activity, Escherichia coli DNA polymerase I, or no measurable exonuclease activity, calf thymus DNA polymerase α, is 12 to 15%, which is similar to that for the T4 polymerases and consistent with $\Delta G = 1.1$ kcal/mol.

26359 Protein synthesis and auxin-induced growth: inhibitor studies. Bates, G.T.; Cleland, R.E. (Univ. of Washington, Seattle). *Planta;* **145**: 437-442(1979).

We have compared the effects of cycloheximide (CHI) and two other rapid and effective inhibitors of protein synthesis, pactamycin and 2-(4-methyl-2,6-dinitroanilino)-N-methyl proprionamide (MDMP), on protein synthesis, respiration, auxin-induced growth and H^+-excretion of Avena sativa L. coleoptiles. All three compounds inhibit protein synthesis without affecting respiration. The effectiveness of the inhibitors against H^+-excretion and growth correlates with their ability to inhibit protein synthesis. Both CHI and MDMP inhibit auxin-induced H^+-excretion after a latent period of 5 to 8 min, and inhibit growth after a 8 to 10 min lag. These results support the idea that continued protein synthesis is required in the initial stages of the growth-promoting action of auxin.

26360 Vitamin C is positive in the DNA synthesis inhibition and sister-chromatid exchange tests. Galloway, S.M.; Painter, R.B. (Univ. of California, San Francisco). *Mutat. Res.;* **60**: 321-327(1979).

Ascorbate caused a dose-dependent increase in sister-chromatid exchanges (SCEs) in Chinese hamster ovary (CHO) cells in human lymphocytes. Moreover, in the DNA synthesis inhibition test with HeLa cells, ascorbate gave results typical of DNA-damaging chemicals. Catalase reduced SCE induction by ascorbate, prevented its cytotoxicity in CHO cells, and prevented its effect on HeLa DNA synthesis. Ascorbate reduced induction of SCE in CHO cells by N-methyl-N′-nitro-N-nitrosoguanidine (MNNG) by direct inactivation of MNNG.

26361 Formation of enzyme-bound and medium pyrophosphate and the molecular basis of the oxygen exchange reaction of yeast inorganic pyrophosphatase. Janson, C.A.; Degani, C.; Boyer, P.D. (Univ. of California, Los Angeles). *J. Biol. Chem.;* **254**: No. 10, 3743-3749(1979).

Yeast inorganic pyrophosphatase, with 10 mM ^{32}P/sub i/ and 10 mM Mg^{2+} present at pH 7.3 to 7.6, rapidly forms enzyme-bound pyrophosphate equivalent to about 5% of the total catalytic sites on the two enzyme subunits. The enzyme thus appears to bind PP/sub i/ so as to favor thermodynamically its formation from P/sub i/. The

enzyme catalyzes a measurable equilibrium formation of free PP/sub i/ at a much slower rate. Under similar conditions, the enzymes catalyzes a rapid exchange of oxygen atoms between P/sub i/ and water with the relative activation by metals being $Mg^{2+} > Zn^{2+} > Co^{2+} > Mn^{2+}$. Millisecond mixing and quenching experiments demonstrate that the rate of formation and cleavage of the enzyme-bound PP/sub i/ is rapid enough to explain most or all of the oxygen exchange reaction.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 26372, 26392, 26393, 26444

26362 Further characterization of a depurinated DNA-purine base insertion activity from cultured human fibroblasts. Deutsch, W.A.; Linn, S. (Univ. of California, Berkeley). Contract EY-76-5-03-0034. *J. Biol. Chem.;* **254**: No. 23, 12099-12103(10 Dec 1979).

The purification from cultured human fibroblasts of a protein that binds specifically to partially depurinated DNA and inserts purines into those sites is described. The purine insertion, but not the binding, requires K^+. The DNA binding can be saturated with increasing apurinic sites and is weakened by the presence of adenine or guanine. Base insertion into depurinated DNA is specific for adenine or guanine; none is observed with dATP or dGTP. When the depurinated DNA substrate is specifically cleaved with apurinic endonuclease, no purine insertion occurs. Guanine insertion does not occur into tRNA or depyrimidinated DNA, and thymine is not inserted into either depyrimidinated DNA or depurinated DNA. Purine insertion activity follows Michaelis-Menten kinetics with respect to purines; the apparent K/sub m/ values for both adenine and guanine are 5 μM. The enzyme binds the purine bases very tightly. Adenine binding saturates at less than 1 μM adenine, perhaps reflecting the low intracellular adenine concentration. The binding protein specific for uv-irradiated DNA had no detectable purine or pyrimidine base insertion activity with depurinated or depyrimidinated DNAs.

26363 Assessment of total catalytic sites and the nature of bound nucleotide participation in photophosphorylation. Rosen, G.; Gresser, M.; Vinkler, C.; Boyer, P.D. (Univ. of California, Los Angeles). Contract EY-76-S-03-0034. *J. Biol. Chem.;* **254**: No. 21, 10654-10661(10 Nov 1979).

Application of a new hexokinase accessibility method for the measurement of bound [^{32}P]ATP during steady state photophosphorylation by chloroplast thylakoids, together with mixing-quenching and filtration techniques has shown the following: (1) two classes of bound ATP exist: a transitorily tightly bound class that represents a catalytic intermediate and a noncatalytic class of tightly bound ATP that is labeled much more slowly, presumably from medium components. Thylakoids filtered after a few seconds of photophosphorylation have some of both classes present. Thus, ATP may remain bound at a catalytic site on membranes in the absence of continued energization. (2) During steady state photophosphorylation, the sum of catalytically competent bound ATP plus P/sub i/ is considerably greater than 1/chloroplast ATP synthase complex even when substrate concentration limits the synthesis rate. At a given instant, therefore, most or all phosphorylation complexes are functional, with the simultaneous participation of more than one catalytic site/enzyme. (3) During photophosphorylation, with substrate concentration well below K/sub m/ values, most ATP synthase complexes retain a bound, catalytic ATP. This behavior is not consistent with independent catalytic sites. These results give additional support to the view developed in this laboratory that ATP synthesis is accomplished by a mechanism in whichtwo catalytic sites are functioning alternately on the ATP synthase. This mechanism proposes that energy-linked conformational changes in the ATP synthase promote binding of P/sub i/ and ADP in a mode competent for ATP synthesis at one catalytic site and concomitantly the release of tightly bound ATP from an alternate site.

26364 Biosynthesis of plasmalogens by the microsomal fraction of Fischer R-3259 sarcoma. Influence of specific 2-acyl chains on the desaturation of 1-alkyl-2-acyl-sn-gycero-3-phosphoethanolamine. Wykle, R.L.; Schremmer, J.M. (Oak Ridge Associated Univ., TN). *Biochemistry;* **18**: No. 16, 3512-3517(7 Aug 1979).

In the Fischer R-3259 sarcoma, ethanolamine plasmalogens are synthesized from 1-akyl-2-acyl-sn-glycero-3-phosphoethanolamine by a microsomal desaturase that inserts a Δ^1 double bond in the alkyl chain. In the present study, a series of 1-[1-^{14}C]hexadecyl-2-acyl-GPE substrates containing specific acyl groups ranging from $C_{2:0}$ to $C_{20:4}$ at the 2 position were prepared and tested as substrates for the microsomal Δ^1-alkyl desaturase. The microsomal preparations contained an acyl hydrolase that removed the $C_{2:0}$, $C_{4:0}$, and $C_{7:0}$ acyl groups from the 2 position. By inhibiting the hydrolase with diisopropyl fluorophosphate, it was possible to test conversion of the unaltered substrates to plasmalogens. The alkyl desaturase exhibited little discrimination among the specific acyl derivatives tested. The highest rate of desaturation was obtained with 1-[1-^{14}C]-hexadecyl-2-acyl-GPE synthesized in situ in the microsomes via acylation of 1-[1-^{14}C]hexadecyl-GPE; this rate was threefold that observed with exogenously acylated substrates. The 1-[1-^{14}C]hexadecyl-2-acyl-GPE synthesized in situ contained highly unsaturated acyl groups; no selectivity of the desaturase for specific acyl chains was detected when the different molecular species of 1-[1-^{14}C]alkyl-2-acyl-GPE and 1-[1-^{14}C]alk-1'-eyl-2-acyl-GPE were compared. The short-chain substrates, being moe hydrophilic, mimicked the chromatographic behavior of 1-alkyl-GPE, yet they did not resemble the lyso compound in its higher conversion to plasmalogens. Thus, despite their similar R/sub f/ values, the packing of the short-chain acyl homologues in the membrane may be quite different from that of the lyso compound. Binding of 1-hexadecyl-2-acyl-GPE and 1-hexadecyl-GPE to microsomal membranes was similar.

CYTOLOGY

REFER ALSO TO CITATION(S) 26360, 26382, 26385, 26399, 26400, 26451

26365 (ANL—79-65(Pt.2), pp 55-64) **Suppression of growth of two human osteosarcoma cell lines by normal human fibroblasts.** Lloyd, E.L.; Gemmell, M.A. 1979.

In Radiological and Environmental Research Division. Annual report.

Two human osteosarcoma cell lines (TE-85 and SaOS-2) with different characteristics of growth and morphology were shown to be inhibited in growth by co-cultivation with a normal human fibroblast strain (NFS). An increase in the number of normal cells up to 10^5 decreased the number and size of colonies of the tumor cells when examined four weeks after seeding. The mechanism whereby the normal cells affect this reduction appears to be a local effect as judged by the grossly abnormal multinuclear cells which predominated at the interface between the normal and tumor cells in one of the tumor cell lines (TE-85). The other tumor cell line (SaOS-2) failed to show these multinuclear cells but appeared to be infiltrated with normal cells interdigitating with the tumor cells at the edge of the tumor cell colonies.

26366 (ANL—79-65(Pt.2), pp 70-75) **Quantitative histology of mastoid air cell epithelium.** Harris, M.J.; Schlenker, R.A. 1979.

In Radiological and Environmental Research Division. Annual report.

A study was made of epithelial cell populations in several mastoid air cells. Data are presented on epithelial and lamina propria thicknesses and on the ratio of nuclear area to epithelial area for dosimetry of these cells which may be at risk for carcinoma from radium.

26367 Some quantitative aspects of the passive sensitization of human basophils. Goldstein, B.; Dembo, M.; Malveaux, F.J. (Los Alamos Scientific Lab., NM). *J. Immunol.;* **122**: No. 3, 830-833(Mar 1979).

The theory for the binding of IgE to Fc receptors on basophil surfaces was reviewed. The theory was then used to analyze binding experiments of Malveaux et al. and T. Ishizaka on the passive sensitization of basophils from a patient with chronic myelocytic leukemia and 75% basophilia. From their data, it was determined that the forward rate constant for the binding of human IgE to receptors on these human basophils is (3.0 +- 1.0) x 10^4 M^{-1} sec^{-1}.

26368 Nuclear ultrastructure of epithelial cell lines derived from human carcinomas and nonmalignant tissues. Smith, H.S.; Springer, E.L.; Hackett, A.J. (Peralta Cancer Research Inst., Oakland, CA). Contract W-7405-ENG-48. *Cancer Res.;* **39**: 332-344(Feb 1979).

The nuclear ultrastructure of sixteen human epithelial cell lines has been characterized in detail by transmission electron microscopy. The cell lines were derived from normal tissues, nonmalignant tissues of cancerous organs, primary carcinomas, and metastatic carcinomas. Every cell section on a grid containing a clearly defined nucleus and nucleolus was scored blindly utilizing a checklist of markers. The goal of these studies was to determine whether any ultrastructural markers consistently distinguished the different stages of malignant progression represented among the lines. Nuclear bodies and perichromatin granules were found in all lines derived from cancer and were not observed in any nonmalignant lines. Nuclear envelope dilation was seen in all lines derived from cancerous organs as well as from malignant tissues but not in any lines derived from normal tissue. Margination of chromatin, irregularity of nuclear outline, redistribution of nucleolar components, and marination were expressed slightly by the normal lines, to variable degrees by the lines derived from cancerous organs, and to a much greater extent by all lines derived from malignant tissues. No differences were found between lines derived from primary carcinomas and those derived from metastatic specimens. There were no ultrastructural differences comparing subconfluent and confluent cells or

cells at different passage levels. In addition, the nuclear ultrastructure of a malignant line in culture was similar to that of a tumor induced by those cells in an immunosuppressed mouse.

26369 Flow microfluorometric identification of liver cells with elevated gamma-glutamyltranspeptidase activity after carcinogen exposure. Vanderlaan, M.; Cutter, C.; Dolbeare, F. (Univ. of California, Livermore). Contract W-7405-ENG-48. *J. Histochem. Cytochem.;* **27**: No. 1, 114-119(1979).

We have developed a fluorometric cytochemical assay for γ-glutamyltranspeptidase (γ-GT) using the substrate γ-glutamyl-4-methoxy-2-naphthylamide in which the release methoxynaphthylamine was coupled with 5-nitrosalicylaldehyde to form a yellow fluorescent crystalline product within the cells. Single cell suspensions were obtained by collagenase perfusion of livers from rats that had either received a two-thirds partial hepatectomy followed 24 h later by a single injection of diethylnitrosamine (DEN) or received a partial hepatectomy alone. Cultured HTC cells were used as a source of GT + cells. Fluorescence (γ-GT activity) was low in most of the cells from both DEN-exposed and control rats, but high in HTC cells. The liver in both DEN-exposed and control rats had a subpopulation of cells that were γ-GT+; this population could be quantitated and sorted by flow cytometry. Five weeks post injection the number of GT+ cells from the rats exposed to DEN was more than 20 times that from the control rats. Increased γ-GT activity may be a useful cytochemical marker for preneoplastic liver cells.

26370 Contribution of tonoplast and plasma membrane to the electrical properties of a higher-plant cell. Goldsmith, M.H.M.; Cleland, R.E. (Yale Univ., New Haven, CT). Contract EY-765-06-2225-T19. *Planta;* **143**: 261-265(1978).

The cytoplasm of subepidermal parenchyma cells of Avena sativa L. coleoptiles was collected at one end of the cell by centrifugation. The electrical properties of both plasmalemma and tonoplast were then examined with microelectrodes inserted into both cytoplasm and vacuole of the same cell. The input resistance of the cytoplasm measured with either electrode was 7.5 +- 0.8 MΩ while that of the vacuole measured with the single vacuolar electrode and a bridge circuit was 29.2 +- 3.1 MΩ. The latter value was not significantly different from that of control, uncentrifuged cells. The resistance of the tonoplast is therefore several times larger than the input resistance of the cytoplasm, but the specific resistance of the plasma membrane cannot be calculated without knowledge of the extent and pattern of intercellular coupling. Electrical coupling of the cytoplasms of adjacent cells was observed in only two out of eight experiments. The mean potential of the vacuoles, -77.8 +- 6.4 mV, was not significantly different from that of the cytoplasm; however, all the available evidence indicates that variable tip potentials in impaled cells made absolute determination of the membrane potential by 20 mV within 10 min. This response occurred entirely at the plasmalemma.

TRACER TECHNIQUES

26371 In vivo cooperation of murine lymphocytes sharing one haplotype of the transplantation genes: a requirement for tolerance of the nonshared haplotype. Marusic, M.; Perkins, E.H. (Univ. of Tennessee Graduate School of Biomedical Sciences, Oak Ridge). Contract W-7405-ENG-26. *J. Immunol.;* **122**: No. 3, 1116-1120(Mar 1979).

The ability of mouse thymus-dependent (T) and bone marrow-derived (B) lymphocytes to cooperate in the (humoral) rejection of the rat Yoshida ascites sarcoma (YAS) was investigated. Mice of two hybrid constitutions that had one parent of the same strain and the other of a different strain were used. T and B cells thus shared one haplotype of the transplantation genes, but the other haplotype was different so that allogeneic recognition could take place in both directions. To investigate the influence of allogeneic recognition on T-B cell cooperation, mice were also made mutually tolerant by establishing long-term radiation chimeras. Erythrocytes and spleen cells of the chimera were shown by serologic analysis to be donor-type. When the chimera was to serve as tumor host and B cell source, it was thymectomized before irradiation and reconstitution with Thy 1.2 antisera and complement-treated bone marrow (TIR). The evidence of tolerance was markedly reduced anti-host-type reactivity in short-term in vivo [^{3}H]thymidine uptake studies. Successful cooperation, manifested by YAS rejection in TIR mice given splenic T cells, was seen (a) whenever the transferred T cells and the cells of the TIR recipient were syngeneic, and (b) when the T cells were nonsyngeneic with the cells in TIR recipients but were obtained from chimeric donors and injected into chimeric recipients. Chimerism of only T cell donorsor TIR recipients was not sufficient for YAS rejection to be induced. The data suggest that the allogeneic recognition on either T or B lymphocytes may thwart otherwise successful cell cooperation.

26372 Photosynthetic oxygen reduction in isolated intact chloroplasts and cells from spinach. Marsho, T.V. (Univ. of Maryland Baltimore County, Catonsville); Behrens, P.W.; Radmer, R.J. Contract EY-76-C-02-3326. *Plant Physiol.;* **64**: 656-659(1979).

The time course of light-induced O_2 exchange by isolated intact chloroplasts and cells from spinach was determined under various conditions using isotopically labeled O_2 and a mass spectrometer. In dark-adapted chloroplasts and cells supplemented with saturating amounts of bicarbonate, O_2 evolution began immediately upon illumination. However, this initial rate of O_2 evolution began immediately upon illumination. However, this initial rate of O_2 evolution was counterbalanced by a simultaneous increase in the rate of O_2 uptake, so that little net O_2 was evolved or consumed during the first ~ 1 minute of illumination. After this induction (lag) phase, the rate of O_2 evolution increased 3- to 4-fold while the rate of O_2 uptake diminshed to a very low level. Inhibition of the Calvin cycle had negligible effects on the initial rate of O_2 evolution or O_2 uptake; both rates were sustained for several minutes, and about balanced so that no net O_2 was produced. Uncouplers had an effect similar to that observed with Calvin cycle inhibitors, except that rates of O_2 evolution and photoreduction were stimulated 40 to 50%. These results suggest that higher plant photosynthetic preparations which retain the ability to reduce CO_2 also have a significant capacity to photoreduce O_2. With near-saturating light and sufficient CO_2, O_2 reduction appears to take place primarily via a direct interaction between O_2 and reduced electron transport carriers, and occurs principally when CO_2 fixation reactions are suboptimal. The inherent maximum endogenous rate of O_2 reduction is approximately 25 to 50% of the maximum rate of noncyclic electron transport coupled to CO_2 fixation. Although the photoreduction of O_2 is coupled to ion transport and/or phosophorylation, this process does not appear to supply significant amounts of ATP directly during steady-state CO_2 fixation in strong light.

GENETICS

REFER ALSO TO CITATION(S) 26385, 26387, 26388, 26400, 26406

26373 (UCRL—52924) **Separation of Chinese hamster chromosomes by velocity sedimentation at unit gravity.** Bont, W.; Gray, J.; Tulp, A.; de Vries, J.; Cram, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Apr 1980. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01.

New techniques are described for the separation of isolated Chinese hamster M3-1 chromosomes by velocity sedimentation at unit gravity. Up to 10^{10} chromosomes were sedimented on simple continuous hexaleneglycol-sucrose gradients. During the sedimentation process non-disrupted cells, nuclei, cellular debris, and damaged chromosomes were easily separated from the intact chromosomes. In addition, the chromosomes themselves were separated into several fractions by size. The chromosomes types in each fraction were determined by flow cytometry.

26374 Rapid isoation of metaphase chromosomes containing high molecular weight DNA. Blumentahl, A.B.; Dieden, J.D.; Kapp, L.N.; Sedat, J.W. (Univ. of California, San Francisco). *J. Cell Biol.;* **81**: 255-259(Apr 1979).

Metaphase chromosomes with high molecular weight DNA were isolated from Chinese hamster ovary (CHO) cells in a neutral buffer containing polyamines and chelators. The individual, unfixed chromosomes retained their centromeric and secondary constrictions, distinct sister chromatids, and complex banding patterns. The DNA from these chromosomes was 100-fold larger (2 x 10^8 daltons) than DNA from chromosomes isolated by other procedures. These characteristics indicate preservation during isolation of considerable native structure. In contrast to chromosomes produced by other methods, these chromosomes were stable in storage and did not aggregate, thus providing useful material for studies of the structure and biochemistry of individual chromosomes.

26375 Computer programs for analyses of inheritance and linkage data. Hanna, W.; Mullinix, B.; Grimes, L. (Univ. of Georgia, Tifton). Contract EY-76-S-09-0637. *Crop Sci.;* **17**: 517(May 1978).

Three computer prorams were developed to aid in analyzing genetic inheritance and linkage data. The inheritance programs test goodness-of-fit of observed data with 1 to 50 theoretical genetic ratios. One program analyzes two-to five-class inheritance data. The second program processes four-class linkage data (two, two-class mutants). The third program analyzes four-class linkage data, prints, the chi-square values for each mutant, calculates a linkage chi-square value, and determines heterogeneity values. Each of the programs is available on request.

METABOLISM

REFER ALSO TO CITATION(S) 26369, 26424, 26448

26376 Evidence for an important physiological role for calcitonin. Talmage, R.V. (Univ. of North Carolina, Chapel Hill); Grubb, S.A.; Norimatsu, H.; VanderWiel, C.J. *Proc. Natl. Acad. Sci. U.S.A.;* **77**: No. 1, 609-613(Jan 1980).

We propose that calcitonin, secreted in response to the intake of food, aids in routing calcium, obtained by intestinal absorption, into bone fluid. Here calcium is temporarily stored in combination with phosphate for return to the extracellular fluid (blood) during intervals between oral intakes of calcium. The net result is a conservation of calcium postprandially and a decrease in parathyroid hormone-induced bone destruction during subsequent fasting periods. Evidence for this postulate is provided in the following six sequential steps from the time a calcium-containing meal is consumed until that portion of calcium stored in bone fluid is utilized during fasting periods to aid in plasma calcium maintenance. (i) Calcitonin secretion is stimulated by feeding and subsequent digestive processes. (ii) Postprandial secretion of calcitonin restricts the efflux of calcium from bone fluid to blood, thereby maintaining parathyroid hormone (PTH) secretion. (iii) In thyroid-intact individuals, both PTH and calcitonin are secreted postprandially and act in concert on calcium homeostasis. (iv) Calcitonin actively moves phosphate into bone and prevents its loss from bone fluid to blood. (v) Postprandial storage of calcium with phosphate occurs in bone fluid of thyroid-intact individuals. (vi) This labile storage form of calcium is the first to be utilized during fasting periods. In the absence of partial disruption of this storage mechanism, rapid development of pathological bone conditions would not be expected because PTH action permits the extended utilization of bone calcium for plasma calcium control. However, augmentation of osteopenic conditions could be expected if long-term low calcium intake were accompanied by a malfunction of this calcination-induced system for calcium storage.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 26445

26377 Endogenous respiration of Polyporus sulphureus. Li, S.M.W. (Battelle Pacific Northwest Labs., Richland, WA); Siehr, D.J. *Mycologia;* **72**: No. 1, 64-72(Jan 1980).

Thirty percent of the dry weight of the basidiomycete Polyporus sulphureus is triterpenoid acid. The endogenous respiratory quotient of this organism is 0.8 indicating that the triterpenoid is being used as an endogenous storage material. Monosaccharides did not seem to be utilized as exogenous substrates but Krebs-cycle intermediates stimulated oxygen uptake. Pyruvic acid inhibited oxygen uptake. Studies with ^{14}C-labeled glucose indicated that 27% of the glucose was metabolized by way of glycolysis. The hexose-monophosphate pathway was the major metabolic path for the utilization of glucose. Despite the fact that P. sulphureus is associated with brown rot, its carbon metabolism suggests that it utilizes substances associated with the degradation of lignin more readily than it does glucose.

MEDICINE

REFER ALSO TO CITATION(S) 26357, 26365, 26425

26378 (ORNL/CSD—56) **Use of mathematical methods in cryosurgery.** Solomon, A.D. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 75p. NTIS, PC A05/MF A01.

Cryosurgery is a technique for the destruction of tissue via cyclic freezing and thawing. It is carried out by placing temperature-controlled probes (cryoprobes) in contact with target tissue and is at this time an established surgical technique. It is natural for one who is familiar with mathematical methods for phase change processes to attempt to apply his expertise to this area, since, superficially at least, the technique is one of pure heat conduction and phase change in a biological medium. In the present paper we discuss some results obtained in this spirit. We begin, in Part I, with the cryosurgical aspects of the modeling process: What are our aims? What is the form of a model. In Part II we describe the mathematical tools available to us, emphasizing those points which are peculiar to the cryosurgical application. Part III is devoted to modeling the freezing of water, while in Part IV we sketch an interactive computer simulation of a cryosurgical procedure. Finally, in Part V we discuss some possibly useful directions of further work.

26379 Phenobarbital treatment in primary biliary cirrhosis. Differences in bile acid composition between responders and nonresponders. Stellaard, F. (Argonne National Lab., IL); Bolt, M.G.; Boyer, J.L.; Klein, P.D. *J. Lab. Clin. Med.;* **94**: No. 6, 853-861(Dec 1979).

We have studied the effect of phenobarbital treatment on total serum bile acid levels and serum bile acid composition in five patients with primary biliary cirrhosis and one patient with sclerosing cholangitis. These patients were divided into two groups according to their apparent response to phenobarbital treatment. One group, consisting of three patients with primary biliary cirrhosis and the patient with sclerosing cholangitis, demonstrated very high initial total serum bile acid levels, which decreased substantially during phenobarbital therapy. There sera had no secondary bile acids, and a decrease in the trihydroy/dihydroxy ratio occurred during phenobarbital therapy. The second group consisted of two primary biliary cirrhosis patients who showed no reduction of bile acids during treatment. Their initial total serum bile acid levels were lower than those in the first group and paradoxically showed a slight increase with phenobarbital therapy. The fact that no significant amounts of unusual bile acids were detected in either group indicates that abnormal pathways of bile acid metabolism were not present and that in all likelihood, phenobarbital did not alter the conventional pathways of bile acid biosynthesis in these five patients.

26380 Proteins of human urine. 1. concentration and analysis by two-dimensional electrophoresis. Anderson, N.G.; Anderson, N.L.; Tollaksen, S.L. *Clin. Chem.;* **25**: No. 7, 1199-1210(Jul 1979).

We briefly review the origins of urinary proteins, as these are now understood, and present a scheme for their separations and evaluation, the ISO-DALT system of two-dimensional electrophoresis. Some results are illustrated and discussed.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

26381 Status of gallium-67 in tumor detector. Hoffer, P. (Yale Univ. School of Medicine, New Haven, CT). EP-78-02-4625. *J. Nucl. Med.;* **21**: No. 4, 394-398(Apr 1980).

The efficacy of gallium-67 citrate in detecting specific tumors is discussed. Tumors in which gallium-67 imaging is useful as a diagnostic tool include Hodgkin's disease, histiocystic lymphoma, Burkitt's lymphoma, hepatoma melanoma, and leukemia. It has not been found to be effective in diagnosing head and neck tumors, gastrointestinal tumors, genitourinary tract tumors, breast tumors, and pediatric tumors. Gallium may be useful in the evaluation of non-Hodgkin's lymphoma, testicular carcinoma, mesothelioma, and carcinoma of the lung. It may also be useful for determining response to treatment and prognosis in some neoplasms.

26382 Assay of mouse-cell clones for retrovirus p30 protein by use of an automated solid-state radioimmunoassay. Kennel, S.J.; Tnnant, R.W. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Virology;* **97**: No. 2, 464-467(Sep 1979).

A solid-state radioimmunoassay system has been developed that is useful for automated analysis of samples in microtiter plates. Assays for interspecies and type-specific antigenic determinants of the C-type retrovirus protein, p30, have been used to identify clones of cells producing this protein. This method allows testing of at least 1000 clones a day, making it useful for studies of frequencies of virus protein induction, defective virus production, and formation of recombinant viruses.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 26259

EXTERNAL RADIATION IN THERAPY

26383 (SAND—80-1033) **D-T neutron generator development for cancer therapy. 1980 annual progress report.** Bacon, F.M.; Walko, R.J.; Bickes, R.W. Jr.; Cowgill, D.F.; Riedel, A.A.; O'Hagan, J.B. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

This report summarizes the work completed during the first year of a two-year grant by NCI/HEW to investigate the feasibility of developing a D-T neutron generator for use in cancer therapy. Experiments have continued on the Target Test Facility (TTF) developed during a previous grant to investigate high-temperature metal hydrides for use as target materials. The high voltage reliability of the TTF has been improved so that 200 kV, 200 mA operation is now routine. In recent target tests, the D-D neutron production rate was measured to be $> 1 \times 10^{11}$/s, a rate that corresponds to a D-T neutron production rate of $> 1 \times 10^{13}$/s - the desired rate for use in cancer therapy. Deuterium concentration depth profiles in the target, measured during intense ion beam bombardment, show that deuterium is depleted near the surface of the target due to impurities implanted by the ion beam. Recent modifications of the duopigatron ion source to reduce secondary electron damage to the electrodes also improved the ion source efficiency by about 40%. An ultra high vacuum version of the TTF is now being constructed to determine if improved vacuum conditions will reduce ion source impurities to a sufficiently low level that the deuterium near the surface of the target is not depleted. Testing will begin in June 1980.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 25222, 25223, 25455, 25586, 25589, 25591, 25592, 26318, 26350, 26358, 26361, 26382, 26404, 26405, 26406, 26450

26384 Selective screening methods for selecting and identifying hyper-cellulolytic microbial mutants; hyper-cellulolytic mutant microorganisms; and processes for their utilization. Montenecourt, B.S.; Eveleigh, D.E. US Patent Application 050,407. [nd]. 61p.

A process for identifying and selecting microorganism strains, e.g., of the Trichoderma reesei species is described. Various hyper-cellulolytic characteristics, as described in greater detail, conducting one or more of various mutation and selection steps in any order or sequence followed by a mutation and selection step for microbial strains with constitutive cellulolytic activity by culturing in this latter step the microbial strains on a general non-enzyme-inducing culture medium and then detecting constitutive mutant microbial strains by overlayering with a culture medium that will detect cellulase and cellobiase activity with the proviso that any further protein synthesis is inhibited is disclosed. The selection process is useful for identifying and selecting microbial strains with the ability to produce various enzymes capable of breaking down various cellulosic and cellobiosic materials into smaller sugar units, e.g., glucose units, which can be subsequently used for the production of alcohol and other organic chemicals in a conventional fermentation process under anaerobic or aerobic conditions. Various novel mutant strains of Trichoderma reesei developed and selected using the approach above and their use in producing enzymes and hydrolysis of cellulosic materials are disclosed.

26385 Characterization of Fv-1 host range strains of murine retroviruses by titration and p30 protein characteristics. Tennant, R.W. (Oak Ridge National Lab., TN); Otten, J.A.; Brown, A.; Yang, W.K.; Kennel, S.J. Contract W-7405-ENG-26. *Virology;* **99**: No. 2, 349-357(Dec 1979).

A standardized, direct XC plaque assay was used to determine the titration hitness patterns of Fv-1 host range murine retroviruses obtained from various laboratories. The N- or B-tropic viruses were tested on a variety of cells with Fv-1/sup nn/, Fv-1/sup bb/, or Fv-1/sup nb/ genotypes, and, with one exception, a discrete two-hit pattern was obtained on cells with the restrictive genotype (i.e., N-tropic virus on BALB/c, SIM.R, and B6C3F_1 cells, and B-tropic virus on SME, SIM, and B6C3F_1 cells). The single exception to the two-hit titration effect was a strain (TOR-B) which is poorly infectious for all cells, and which does not show a clear N- or B-tropism. In addition, it was possible to convert the two-hit pattern of another B-tropic virus (OR-B) to a one-hit curve by coinfection with an XC-negative N-tropic virus. Relative to SC-1 (Fv-1^{--}) cells, it was possible to define three components of restriction of ecotropic virus infection of mouse cells: The first two components, the two-hit kinetics and 10^2- to 10^3-fold reduction in titer on restrictive cells, are Fv-1 determined; the third a decreased infectivity on all cells relative to SC-1 cells, is independent of Fv-1 genotype.

26386 Isolation from soil and properties of the extreme thermophile Clostridium thermohydrosulfuricum. Wiegel, J.; Ljungdahl, L.G.; Rawson, J.R. (Univ. of Georgia, Athens). *J. Bacteriol.;* **139**: No. 3, 800-810(Sep 1979).

Thirteen strains of a strict anaerobic, extreme thermophilic bacterium were isolated from soil samples of moderate temperature, from a sewage plant in Georgia, and from hot springs in Utah and Wyoming. They were identified as strains of Clostridium thermohydrosulfuricum. The guanosine + cytosine content (moles percent) was 37.6 (determined by buoyant density) and 34.1 (determined by melting temperature). All strains required a factor present in yeast extract or tryptone for growth. Growth characteristics were as follows: a pH range of 5 to 9, with the optimum between 6.9 to 7.5, in a temperature range of 40 to 78°C, with the optimum at 68°C. The doubling time, when grown on glucose at temperature and pH optima, was 1.2 h. The main products of glucose fermentation were ethanol, lactate, acetate, CO_2, and H_2. The fermentation was inhibited by H_2. Formation of spores occurred easily on glucose-agar medium or when cultures growing at temperatures above 65°C were allowed to cool to temperatures below 55°C. C. thermohydrosulfuricum occurs widely distributed in the natural environment.

26387 Extrachromosomal psi$^+$ determinant suppresses nonsense mutations in yeast. Liebman, S.W.; Sherman, F. *J. Bacteriol.;* **139**: No. 3, 1068-1071(Sep 1979).

The extrachromosomal psi$^+$ determinant in the yeast Saccharomyces cerevisiae enhanced the expression of Mendelian UAA suppressors by 6- to 10-fold. The psi$^+$ determinant by itself is a weak UAA suppressor that caused the production of approximately 1% of the normal level of iso-1-cytochrome c in a strain containing the UAA mutation cycl-72.

26388 Organization and transfer of heterologous chloramphenicol and tetracycline resistance genes in pneumococcus. Shoemaker, N.B.; Smith, M.D.; Guild, W.R. (Duke Univ., Durham, NC). *J. Bacteriol.;* **139**: No. 2, 432-441(Aug 1979).

The cat and tet genes of chloramphenicol- and tetracycline-resistant clinical isolates of Streptococcus pneumuoniae from Paris and Japan were shown to be contained in adjacent heterologous insertions into the chromosome. The two insertions transformed laboratory strains at frequencies that were low, unequal, and, for tet, very sensitive to the length of the donor deoxyribonucleic acid strand. In contrast, the transforming activity of cat was relatively stable. There was an unusual asymmetric cotransfer, in that a majority of the tet transformants also acquired cat, whereas only a few of the cat transformants also acquired tet. The evidence for chromosomal insertion came from genetic data showing linkage of cat to a chromosomal gene and from cosedimentation of cat with chromosomal markers in both velocity and dye-buoyancy experiments. Genes on a known plasmid introduced into pneumococcus from Streptococcus faecalis showed very different physical behavior. Most of the transformation properties of these genes can be readily accounted for by analogy to transformation of deletions of normal genes. Whether transposition contributes any of the transfers remains to be determined. The presence of one of the genes in the recipient promoted the integration of the other, demonstrating enhanced accumulation of heterologous genes by a process that did not involve plasmids in the species of concern.

26389 Isolation of Legionella pneumophila from nonepidemic-related aquatic habitats. Fliermans, C.B. (E.I. du Pont de Nemours and Co., Aiken, SC); Cherry, W.B.; Orrison, L.H.; Thacker, L. *Appl. Environ. Microbiol.;* **37**: No. 6, 1239-1242(Jun 1979).

Continuous centrifugation of large volumes of water from natural southeastern lakes allowed quantitative detection of Legionella pneumophila by direct immunofluorescent staining. Positive samples were injected intraperitoneally into guinea pigs, and the L. pneumophila were isolated and identified by their morphological, cultural, physiological, and serological characteristics.

PATHOLOGY

REFER ALSO TO CITATION(S) 26395, 26441, 26451, 26452, 26454

26390 Hormonally induced tumors of the reproductive system of parabiosed male rats. Brown, C.E.; Warren, S.; Chute, R.N.; Ryan, K.J.; Todd, R.B. (Harvard Univ., Boston, MA). *Cancer Res.;* **39**: 3971-3976(Oct 1979).

Parabiosis of intact male rats to castrated males or oophorectomized females for a period of approximately 20 months resulted in three interstitial cell tumors of the testis. When unilateral nephrectomy was added to the parabiotic procedure in ten pairs, eight interstitial cell tumors of the testis and four adenocarcinomas of the prostate occurred in the target male parabionts. These changes were preceded by elevations in luteinizing and follicle-stimulating hormone levels in the serum of the castrates and high levels of testosterone and, to a lesser degree, of androstenedione in the target partners developing the tumors.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 26367, 26376, 26390, 26442, 26450, 26451, 26452, 26454, 26507

26391 (UR—3490-1817) **Development of the adrenal axis in the neonatal rat.** Guillet, R. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1977. Contract AC02-76EV03490. 116p. NTIS, PC A06/MF A01.

Thesis.

Plasma corticosterone and ACTH concentrations were determined in neonatal rats 1, 7, 14, and 21 days old, under a variety of experimental conditions, to obtain more information on the postnatal development of the rat hypothalamo-adrenal (HHA) axis. The results indicate that: (1) there is a diminution followed by an increase in responsiveness of the adrenal gland, but the pituitary response to direct hormonal stimulation is unchanged during the first three postnatal weeks; (2) continued stimulation of the adrenal by ACTH or of the central nervous system (CNS) or hypothalamus by corticosterone is necessary during early postnatal development to allow normal maturation of the HHA axis; and (3) feedback inhibition is operative by birth, at least to a moderate degree. Taken together, the studies suggest that both the adrenal and pituitary glands are potentially functional at birth, but that the hypothalamic and CNS mediators of the stress response are not mature until at least the second or third postnatal week. (ERB)

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 26371

26392 Aggregation properties of the 1,25-dihydroxyvitamin D_3 receptor from chick intestinal cytosol. Franceschi, R.T.; DeLuca, H.F. (Univ. of Wisconsin, Madison). Contract EY-76-S-02-1668. *J. Biol. Chem.;* **254**: No. 22, 11629-11635(25 Nov 1979).

The sedimentation behavior of the chick intestinal cytoplasmic receptor for 1α,25-dihydroxyvitamin D_3 has been examined in buffers containing varying concentrations of KCl. The receptor, which sediments at 3.7 S in 0.3 M KCl, was shown to aggregate to species sedimenting at approximately 5 S in 0.06 M KCl and 6.2 S in the absence of KCl. Depending on the preparation and route used to label the receptor with 1,25-dihydroxy[^{3}H]vitamin D_3, larger aggregates which sedimented to the bottom of sucrose gradients were also seen. Aggregated receptor like the 3.7 S species specifically binds 1,25-dihydroxyvitamin D_3 with high affinity and low capacity. In the absence of KCl, aggregated receptor eluted as a heterogeneous peak near the void volume of a Sephadex G-200 column. In 0.3 M KCl, receptor eluted from the same column with an apparent molecular weight of 60,000. Aggregated receptor prepared from G-200 columns in the absence of KCl could be converted back to a 3.7 S species by adding KCl to a concentration of 0.3 M. Receptor aggregation was shown to be caused, at least in part, by the interaction of receptor with other cytoplasmic components which contaminate crude receptor preparations. These factors are present in both liver and intestinal cytosol. Aggregation of receptor, which was maximal in cytosol labeled with 1,25-dihydroxy[^{3}H]vitamin D_3 at 0°C, was gradually lost withconcomitant increases in 3.7 S material when preparations were incubated at 25°C. This loss of receptor aggregation appears to be due, at least in part, to changes in the receptor molecule itself rather than the inactivation or degradation of cytoplasmic aggregating factors.

26393 Effects of thio-group modification and Ca^{2+} on agonist-specific state transitions of a central nicotinic acetylcholine receptor. Lukas, R.J.; Morimoto, H.; Bennett, E.L. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Biochemistry;* **18**: No. 11, 2384-2395(29 May 1979).

Agonist-binding affinities of central nervous system nicotinic acetylcholine receptors (nAcChR) are sensitive to the duration of exposure to agonist. These agonist-induced changes in receptor state may be mimicked by appropriate modification of receptor thio groups and/or by manipulation of solvent ionic composition. In the absence of Ca^{2+}, the concentration of acetylcholine (AcCh) necessary to prevent half of specific ^{3}H-labeled α-bungarotoxin binding is 1 mM for nAcChR treated with dithiothreitol (DTT) or DTT-N-ethylmaleimide (low-affinity states) and 40 μM for nAcChR treated with DTT-5,5'-dithiobis(2-nitrobenzoic acid) or for native nAcChR pretreated with AcCh (high-affinity states). Addition of Ca^{2+} results in an increase in the effectiveness of AcCh toward blocking toxin binding. None of these treatments alters toxin or antagonist binding nor are there observed differences in Hill numbers for agonist binding. Agonists competitively inhibit toxin binding to low-affinity states, but noncompetitive inhibition is observed for binding to high-affinity states. Values of AcCh dissociation constants estimated from these data fall within the range of values determined physiologically with nAcChR from other systems. The data indicate that the redox state of brain nAcChR thio groups and Ca^{2+} may mediate physiologically important changes in the receptor state during activation and desensitization.

26394 (UCRL-Trans—11523) **Biochemistry and physiology of the effect of SO_2 on plants.** Ziegler, I.; Ziegler, H. Translated from *VDI (Ver. Dtsch. Ing.) Ber.;* No. 314, 219-223(1978). 15p. NTIS, PC A02/MF A01.

In common with CO_2, SO_2 is also absorbed into the leaf mainly through the stomata. Stomata are pores in the epidermis, and their size is regulated by the guard cells. When leaves are briefly fumigated with $^{35}SO_2$, an accumulation of radioactive sulfur is found in the guard cells, depending on the entry location. The following lectures will report on the correlation of CO_2 and SO_2 absorption and on the effect of SO_2 on this mechanism. Processes occurring at the enzymatic and cytophysiological levels are outlined.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 26389

26395 (CONF-791188—2) **Computer mapping of cancer mortality by census tract: Columbus, Ohio, 1956-1974.** Calle, E.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From 4. international symposium on computer assisted cartography; Reston, VA, USA (4 Nov 1979).

A phenomenon of considerable epidemiologic interest in cancer research is the pronounced effect of geographic location on cancer mortality. Most cancer rates vary markedly by country and within regions of the same country. These differences have given rise to national and international research in an attempt to identify the environmental and demographic factors associated with high risk areas. The technique of mapping provides a most effective means of describing the geographic differences in cancer rates, identifying patterns of elevated mortality, and generating etiologic hypotheses. The present study examines the geographic variation of cancer mortality in Columbus, Ohio using the Poisson distribution to judge the significance of standard mortality ratios adjusted for age, sex, and race. Total Columbus age, sex, and race-specific rates for a variety of cancer sites are used to generate expected numbers of deaths. The census tract serves as the basic unit of analysis and comparison of intracommunity risk.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 25695, 26435, 26450

TRACER TECHNIQUES

26396 (MLM—2715) **Enriched isotope applications: agricultural field.** DeWitt, R. (Mound Facility, Miamisburg, OH (USA)). 9 Jun 1980. Contract AC04-76DP00053. 41p. NTIS, PC A03/MF A01.

Enriched stable isotopes for tracer uses in agriculture and related fields were identified. Based on a survey of current studies and available world production capacity, the projected growth in isotope tracer applications was determined. Enriched stable isotopes were identified for which the future demand could exceed current production capacity. In addition, enriched isotopes, not now available in sufficient quantities at reasonable unit costs that may be required for future tracer studies, were also identified. Recommendations were made to ensure future adequate supplies of enriched stable isotopes for use in the agricultural field.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

26397 Identification of essential amino-acid residues in Azotobacter vinelandii isocitrate dehydrogenase by radical anions and H atoms. Schubert, J. (Hope Coll., Holland, MI); Chung, A.E.; Gordon, S. *Radiat. Res.;* **80**: No. 3, 440-446(Dec 1979).

Pure TPN^+-specific isocitrate dehydrogenase from Azotobacter vinelandii was irradiated with H atoms generated in a γ-irradiated solution at pH 6.5. A G(-activity) = 0.12 +- 0.01 was found. At the same time no corresponding loss in free sulfhydryls was observed. These results confirmed the essentiality of methionine for the enzymatic activity as known from previous studies. Irradiation with the radical anions, $(CNS)_2^-$ and Br_2^- generated in γ-irradiated solutions at pH 6.5, strongly inactivated isocitrate dehydrogenase with yields of G(-activity) of 2.1 and 3.9, respectively. Part of the inactivating effect, however, is due to oxidation of sulfhydryl groups. These results lead to the conclusion that tryptophan is an essential amino-acid residue to isocitrate dehydrogenase from A. vinelandii. The presence of tryptophan in the enzyme was demonstrated by pulse radiolysis.

IN MAN

26398 (ANL—79-65(Pt.2), pp 85-114) **Toward a theory of the initiation of cancer by alpha, beta, and x radiation: the twin doublet model.** Marshall, J.H.; Pagnamenta, A. 1979.

In Radiological and Environmental Research Division. Annual report.

Information concerning the basic mechanics of interaction of radiation with matter at both the cellular and the molecular levels may now be sufficient to allow an extension of the cellular model of cancer induction to the level of individual particle tracks, ionizations, and particular bonds in the DNA molecule. The Doublet model appears promising as a candidate for the initial damage to DNA involved in cell killing, mutation, and a single cancer initiation.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

26399 (BNL—27643) **DNA repair in human cells exposed to combinations of carcinogenic agents.** Setlow, R.B.; Ahmed, F.E. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 11p. (CONF-800476—1). NTIS, PC A02/MF A01.

From 13. Jerusalem symposium on carcinogenesis: fundamental mechanisms and environmental effects; Jerusalem, Israel (28 Apr 1980).

Normal human and XP^2 fibroblasts were treated with uv plus uv-mimetic chemicals. The uv dose used was sufficient to saturate the uv excision repair system. Excision repair after combined treatments was estimated by unscheduled DNA synthesis, BrdUrd photolysis, and the loss of sites sensitive to a uv specific endonuclease. Since the repair of damage from uv and its mimetics is coordinately controlled we expected that there would be similar rate-limiting steps in the repair of uv and chemical damage and that after a combined treatment the total amount of repair would be the same as from uv or the chemicals separately. The expectation was not fulfilled. In normal cells repair after a combined treatment was additive whereas in XP cells repair after a combined treatment was usually less than after either agent separately. The chemicals tested were AAAF, DMBA-epoxide, 4NQO, and ICR-170.

26400 **Ionizing radiation-induced 6-thioguanine-resistant clones in synchronous CHO cells.** Burki, J. (Univ. of California, Berkeley). *Radiat. Res.;* **81**: No. 1, 76-84(Jan 1980).

When cultured Chinese hamster ovary (CHO) cells are exposed to acute doses of ionizing radiation at different times during the cell division cycle, there is a characteristic cell-cycle response for radiation-induced cell killing and induced resistance to 6-thioguanine (6TG). For cell killing the sensitive periods of the cell cycle are the G1, G2, M, and early S periods, as others have reported. For mutation induction the sensitive stage is the G1 period with the maximum sensitivity near the boundary between the G1 and the S period. Cells appear to be very refractile to induction of 6TG resistance in other periods of the cell cycle. These results suggest that chromosomal rearrangements of the X chromosome are most likely to occur in the G1 period before the gene for hypoxanthine-guanine-phosphoribosyl-transferase replicates, most likely due to genetic recombination. Clones resistant to 6TG after exposure to x rays are most likely induced by a different mutagenic pathway than ones stimulated by ultraviolet (uv) or ethylnitrosourea treatments, since the mutation induction patterns in the cell cycle are quite different.

26401 **Overlapping pathways for repair of damage from ultraviolet light and chemical carcinogens in human fibroblasts.** Brown, A.J. (Oak Ridge National Lab., TN); Fickel, T.H.; Cleaver, J.E.; Lohman, P.H.M.; Wade, M.H.; Waters, R. *Cancer Res.;* **39**: 2522-2527(Jul 1979).

DNA excision repair was measured in cultured human fibroblasts after single or dual treatments with ultraviolet radiation, 4-nitroquinoline 1-oxide, or N-acetoxy-2-acetylaminofluorene. Three approaches were used to monitor repair: unscheduled DNA synthesis, measured by autoradiography; repair replication, measured by the incorporation of a density-labeled DNA precursor into repaired regions; and excision of ultraviolet endonuclease-sensitive sites. When a single repair-saturating dose of one of the three carcinogens was administered, little stimulation of unscheduled DNA synthesis or repair replication could be observed by additional treatment with one of the other carcinogens. In no instance was total additivity of repair observed. These observations were confirmed by showing that the excision of endonuclease-sensitive sites produced by ultraviolet damage (i.e., pyrimidine dimers) was inhibited by exposure to 4-nitroquinoline 1-oxide and N-acetoxy-2-acetylaminofluorene. The data indicate that the repair of lesions induced by these substances may have common rate-limiting steps, a conclusion previously indicated by the repair deviciency in xeroderma pigmentosum cells in which a single mutation eliminates the repair of damage caused by each of these agents.

26402 **Changes in repair competency after 5-bromodeoxyuridine pulse labeling and near-ultraviolet light.** Hagan, M.P.; Elkind, M.M. (Argonne National Lab., IL). *Biophys. J.;* **27**: No. 1, 75-85(Jul 1979).

Synchronized V79 Chinese hamster cells, pulse-labeled with 5-bromodeoxyuridine (BrdUrd), show marked changes in the sensitivity to near-ultraviolet light during the cell cycle. Cells are least sensitive during the remainder of the S-phase after the BrdUrd pulse. They become maximally sensitive in the next cell cycle when the BrdUrd-labeled DNA presumably serves as the template for replication. This is followed by a return to relative insensitivity during the remainder of that S-phase. When BrdUrd is given both near the beginning and again near the end of the same S-phase, the increase in survival does not occur until DNA synthesis progresses beyond the time when the DNA made during the second pulse serves as a template. Furthermore, cells in the resistant phases of the cell cycle are sensitized by 1-2 mM caffeine. Survival curves are shown for the various cell ages of interest and are discussed in relation to the observed changes in functional repair capacity. The data support the hypothesis that lesions in the BrdUrd-containing DNA are effectively repaired after semiconservative replication. The data indicate that saturation of repair capacity and not target multiplicity is responsible for the appearance of a shoulder on these survival curves.

INTERNAL SOURCE

26403 (ANL—79-65(Pt.2)) **Radiological and Environmental Research Division. Annual report.** (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 237p. NTIS, PC A11/MF A01.

Seventeen papers are presented with abstracts. In addition, five abstracts without papers are included for related topics, i.e., in-vitro inhibition of cell growth; suppression of B.P.-transformed foci in cells; plutonium in drinking water; radioactive properties and biological behavior of radon; and radioactivity and health status of former thorium workers. Two appendices dealing with exposure data for radium patients and radium-induced malignancies are included. (DAD)

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

26404 **Survival of Escherichia coli strains differing in DNA repair capability after irradiation by fission-spectrum neutrons.** Peak, M.J.; Webb, R.B.; Ainsworth, E.J. (Argonne National Lab., IL). *Radiat. Res.;* **81**: No. 1, 145-149(Jan 1980).

The survival of Escherichia coli strains K12 AB1157, AB2463, AB1886, and AB2480 was measured after irradiation with fission neutrons from the Argonne JANUS facility. All inactivations were exponential. Strains AB1157, AB2463, and AB1886 had similar sensitivities, whereas AB2480 was about twice as sensitive (D_0 values of 4×10^3 and 1.7×10^3 rad, respectively). No increases in mutation caused by neutrons were observed in strain AB1157 (at 5% survival level) or in strain AB2480 (at 0.2% survival level) for induction of resistance to phage T5.

26405 **Deoxyribonucleic acid repair capacities of Neisseria gonorrhoeae: Absence of photoreactivation.** Campbell, L.A.; Yasbin, R.E. (Pennsylvania State Univ., University Park). *J. Bacteriol.;* **140**: No. 3, 1109-1111(Dec 1979).

No difference in survival was observed when ultraviolet-irradiated gonococcal cells were subsequently incubated in the dark or exposed to photoreactivating light. This observation indicates that photoreactivation is absent in Neisseria gonorrhoeae.

26406 **Metabolic suppressors of trimethoprim and ultraviolet light sensitivities of Saccharomyces cerevisiae rad6 mutants.** Lawrence, C.W.; Christensen, R.B. (Univ. of Rochester, NY). *J. Bacteriol.;* **139**: No. 3, 866-876(Sep 1979).

Dominant mutations at two newly identified loci, designated SRS1 and SRS2, that metabolically suppress the trimethoprim sensitivity of rad6 and rad18 strains, have been isolated from trimethoprim-resistant mutants arising spontaneously in rad6-1 rad18-2 strains of the yeast Saccharomyces cerevisiae. The SRS2 mutations also efficiently suppress the ultraviolet light sensitivity of the parent strains. They do not, however, suppress their sensitivity to ionizing radiation or their deficiency with respect to induced mutagenesis and sporulation. Such observations support the hypothesis that RAD6-dependent activities can be separated into two functionally distinct groups: a group of error-free repair activities that are responsible for a large amount of the radiation resistance of wild-type strains and also for their resistance to trimethoprim, and a group of error-prone activities that are responsible for induced mutagenesis and are also important in sporulation, but which account at best for only a very small amount of wild-type recovery.

RADIATION EFFECTS ON ANIMALS

26407 **Thermoregulatory considerations in the neurological response to microwave exposure.** Michelson, S.M. (Univ. of Rochester, NY). pp 280-292 of Proceedings of the 2nd international industrial and environmental neurology congress. Klimkova-Deutschova, E.; Lukas, E. (eds.). Prague, Czechoslovakia; Univerzita Karlova (1976).

From 2. International industrial and environmental neurology congress; Prague, Czechoslovakia (1974).

For the purposes of this presentation, microwaves are defined as that portion of the electromagnetic energy spectrum which contains the frequency range of 300 MHz to 300 GHz (i.e., wavelengths in free space of 1 m to 1 mm). Although most published data indicate that the effects of microwave exposure are responses to altered

thermal gradients or to hyperthermia, some responses are referrable to central nervous system reaction. The interpretation that should be placed on these studies is not always clear. This is partly due to an inadequate planning of studies and analysis of results.

MAN

26408 (AD-A—077412/5) **The triarylmethane photochromic system for flashblindness protection. Progress report.** Herz, M.L.; Sousa, J.A.; Levasseur, L.A.; Healy, E.M. (Army Natick Research and Development Command, MA (USA)). 10 Aug 1978. 27p. NTIS, PC A03/MF A01.

A systematic study of three triarylmethane derivatives, synthesized for the purpose of providing improved flashblindness protection, was carried out. Use of photochromic compounds improved protection against flashblindness was evaluated. The systematic study of three triarylmethane compounds, synthesized specifically for use in eye protection devices, was carried out. Their characteristics which are essential to eye protection (ie, absorption, speed of response, photostability), were measured to demonstrate the feasibility of the approach and to describe the current status of photochromic flashblindness protection.

26409 (DOE/EV—0072/11) **Eleventh annual report of radiation exposures for DOE and DOE contractor employees.** (Department of Energy, Washington, DC (USA). Office of Environmental Compliance and Overview). 1978. 61p. NTIS, PC A04/MF A01.

In 1968, the US Atomic Energy Commission (AEC) established a program for reporting certain occupationa radiation exposure information to a central radiation records repository maintained at the Union Carbide Computing Technology Center, Oak Ridge, Tennessee. Annual summaries (WASH-1350-R1 through WASH-1350-R6) were reported for the years 1968-1973 and included data on AEC contracter employees as well as employees of companies in the private sector licensed by the AEC. In January 1975, the operational functions of the AEC, including the maintenance of records on the occupational radiation exposure on contractor employees, were transferred to the Energy Research and Development Administration (ERDA) and the AEC's regulatory functions, including the reporting of information on the occupational radiation exposure of licenses, were transferred to the Nuclear Regulatory Commission (NRC). Previous AEC licenses then reported to NRC while the contractors reported to ERDA. On October 1, 1977, the Department of Energy (DOE) was formed and assumed the responsibilities of ERDA. This report contains the 1978 radiation exposure data for DOE and DOE contractors.

26410 **Late radiation encephalopathy in the dog.** Michaelson, S.M.; Kramer, M.W. (Univ. of Rochester, NY). pp 349-365 of Proceedings of the 2nd international industrial and environmental neurology congress. Klimkova-Deutschova, E.; Lukas, E. (eds.). Prague, Czechoslovakia; Univerzita Karlova (1976).

From 2. International industrial and environmental neurology congress; Prague, Czechoslovakia (1974).

The Research Group on Industrial and Environmental Neurology has suggested that assessment of cerebral atherosclerosis should be considered as part of its purview of problems of interest. Although the present study is not related to the ordinary environmental or industrial situation, it can apply to accidental over-exposure to external ionizing radiation or radiation therapy and describes an animal model that can be used for fundamental study of cerebral vascular conditions and encephalomalacia. Ionizing radiation damage to nervous tissue may be apparent early after irradiation or may become evident after a variable latent period. The concept of late ionizing radiation-induced neuropathy, the subject of this study, is characterized by (a) a long latent period between exposure and initial clinical signs, (b) an inverse relationship between radiation dose and latency of appearance of late radiation encephalopathy, and (c) an apparent lack of demonstrable physiological, biochemical, and morphological alterations until necrosis becomes manifest.

VERTEBRATES

REFER ALSO TO CITATION(S) 26371, 26398

26411 **Quantitation of the late effects of x radiation on the large intestine.** Black, W.C.; Gomez, L.S.; Yuhas, J.M.; Kligerman, M.M. *Cancer;* **45**: No. 3, 444-451(1 Feb 1980).

A model for quantitating late effects of x radiation on the large intestine utilizing the rectum of the Sprague-Dawley rat is reported. This model was constructed prefatory to establishing relative biological effectiveness for negative pions as a component of preclinical trials at the Clinton P. Anderson Meson Physics Facility. The endpoint involves microscopic evaluation of the severity of the experimental lesion, compared with surgically resected bowel lesions we have studied following clinical radiation exposure of the bowel. Individual components of the overall lesion include mucosal ulceration, a typical epithelial regeneration, colitis cystica profunda, fibrosis, and vascular sclerosis. Dose response curves were established for animals receiving 1, 2, 5 and 10 fractions with groups sacrificed at both four and 12 months after completion of radiation exposures.

26412 **Investigation of sensitivity of the hypothalamus to corticosteroids at late postradiation stages.** Prokudina, E.A. (Central Scientific Research Inst. of Roentgenology and Radiology, Leningrad, USSR). *Radiobiology (USSR) (Engl. Transl.);* **18**: No. 4, 172-175(Mar 1979).

Translated from Radiobiologiya; 18: No. 4, 624-627(1978).

Corticosteroid receptors have been found in neurons of the hypothalamus, hippocampus, septum and amygdaloid nucleus. Analysis of the effects of corticosteroids on receptor structures of the hypothalamoreticulolimbic complex revealed complex correlations between them and possibility of concurrent effects of corticosteroids on adrenergic, serotoninergic and cholinergic systems. Expressly in these systems of the hypothalamus some substantial disturbances were found at late postradiation stages. In view of the fact that the mechanism of negative feedback is implemented in the centers of regulation of the adrenohypophyseal system, examination of the reaction of this system to corticosteroids could serve as one of the indicators of the state of its centers. We applied this principle to our study of the functional state of the hypothalamus at the long postradiation term.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

REFER ALSO TO CITATION(S) 26409

MAN

REFER ALSO TO CITATION(S) 26366, 26403, 26418, 26419

26413 (ANL—79-65(Pt.2), pp 39-53) **Cells at risk for the production of bone tumors in man: an electron microscope study of the endosteal surface of control bone and bone from a human radium case.** Lloyd, E.L.; Henning, C.B. 1979.

In Radiological and Environmental Research Division. Annual report.

The endosteal cells of bone from a radium dial worker are documented for the first time by electron microscopy. Fresh samples of bone and tumor tissue from the femur were made available as a result of amputation for a fibrosarcoma in the region of the right knee joint. Bone was examined from a site proximal to the tumor where no invasion of tumor tissue was evident. The patient, who was exposed at age 16 in 1918, died in 1978 with a terminal body burden, calculated to be 1.2 μCi, ^{226}Ra. A sample of bone, also obtained at amputation from an unirradiated control patient, age 65, was examined from the same site in the femur. A comparison of the bone bone-marrow interface from the two patients showed that, unlike the control bone where cells were seen close to bone mineral, an intervening fibrotic layer was interposed between the marrow cells and the bone mineral in the radium bone. This layer varied in thickness up to 50 μm and was usually acellular, although cell remnants and occasionally cells, which appeared viable, were seen. Autoradiographs of sections of bone adjacent to those used for the electron microscope studies are being evaluated.

26414 (ANL—79-65(Pt.2), pp 66-69) **Stripping of the alpha spectrum from a bone with a non-uniform depth distribution of radium.** Mausner, L.F.; Schlenker, R.A. 1979.

In Radiological and Environmental Research Division. Annual report.

The alpha particle energy spectrum of ^{226}Ra and its daughters in a bone has been resolved into its components. The peaked nature of this spectrum is interpreted as due to a concentraion of radionuclides near the endosteal surfaces of the bones of this individual. The calculated results have been compared to direct measurements of the ^{226}Ra and ^{241}Po distributions contained by alpha-gamma coincidence techniques.

26415 (ANL—79-65(Pt.2), pp 76-84) **Dosimetry of head carcinomas in radium cases.** Schlenker, R.A.; Harris, M.J. 1979.

In Radiological and Environmental Research Division. Annual report.

Dose rate calculations, combined with observations of tissue dimensions, lead to the conclusion that radon and its daughters in the airspace produce a greater dose rate in the mastoid air cell epithelium, the tissue at risk for mastoid carcinomas in radium cases, than do radium and its daughters in bone. As the conclusion is based on limited tissue data, assumed values for the radioactivity in bone and airspace, and a number of important assumptions, it must be considered tentative.

26416 (ANL—79-65(Pt.2), pp 136-142) **Mitogenic stimulation of peripheral lymphocytes of thorium workers.** Serio, C.S.; Henning, C.B.; Lloyd, E.L. 1979.

In Radiological and Environmental Research Division. Annual report.

Mitogenic stimulation of lymphocyte cultures from 30 thorium workers was studied to determine whether their immunocompetence was affected by their occupational exposure to radiation. A decrease in lymphocyte responsiveness was seen in these workers when compared with age-matched normal control subjects. The mean decrease relative to the normal controls for three different mitogens tested was 26% with phytohemagglutinin, 40% with concanavalin A, and 30% with poke week mitogen.

26417 (ANL—79-65(Pt.2), pp 143-146) **Chromosome breakage in peripheral lymphocytes of thorium workers.** Hoegerman, S.F.; Cummins, H.T. 1979.

In Radiological and Environmental Research Division. Annual report.

Cytogenic analysis of 21 thorium workers and 3 controls has not shown a significant elevation in the level of chromosome breakage in the workers' peripheral lymphocytes. The observation of a single dicentric chromosome in 100-cell samples from each of two workers with relatively long periods of occupational exposure and relatively high body burdens suggests, however, that such exposure might result in increases in chromosome aberration frequency.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 25371, 26381, 26413, 26414, 26415

26418 (ANL—79-65(Pt.2), pp 13-20) **Radon daughters in the occupants of a house with an unusually high concentration of airborne radon.** Rundo, J.; Sha, J.Y.; Toohey, R.E. 1979.

In Radiological and Environmental Research Division. Annual report.

The residents of a house which has high radon concentrations contain easily measurable levels of radon daughters (typically ~ 400 Bq of ^{214}Bi). The results of the measurements are reported and some calculations of absorbed dose to lung, and of the growth of ^{210}Pb in vivo are presented. The relevance of the findings to the problem of assay of plutonium in lung is also discussed.

26419 (ANL—79-65(Pt.2), pp 115-119) **Distribution of plutonium amongst and within selected bones from an injection case.** Larsen, R.P.; Oldham, R.D.; Martin, S.M. 1979.

In Radiological and Environmental Research Division. Annual report.

The burden and macrodistribution of plutonium in the skeleton of a man who received 0.38 μCi of ^{239}Pu by injection were determined. The relative concentrations in the bones analyzed are comparable to those obtained in a study of another subject. The concentrations in the trabecular and cortical portions of these bones were determined; the concentration ratio ranged from 1.9 to 4.7. The data show that (1) within a bone the plutonium concentration in the trabecular portion is always higher than it is in the cortical portion, but (2) within a group of bones plutonium concentration is not correlated with degree of trabecularity.

26420 (ANL—79-65(Pt.2), pp 120-121) **Concentration of plutonium in hair following intravenous injection.** Toohey, R.E.; Cacic, C.G.; Oldham, R.D.; Larsen, R.P. 1979.

In Radiological and Environmental Research Division. Annual report.

The concentration of plutonium has been determined along the length of the hair of a female subject who received 11.1 kBq (0.3 μCi) of ^{239}Pu by intravenous injection in 1945. The subject succumbed to her preexisting illness 518 days post-injection. The growth rate of hair given for females in ICRP is 0.36 mm/day, and so a half-length of 43 +- 9 mm corresponds to a half-time of 120 +- 25 days. However, since plutonium was found in the most distal portion of the hair, an average growth rate of at least 280 mm/518 days, or 0.54 mm/ day is indicated for this individual. This value yields a half-time of 80 +- 20 days for the long-lived component of plutonium concentration in the hair and therefore also in the blood. This half-time is in excellent agreement with that of 88 +- 13 days found for the plutonium injection cases.

26421 (ANL—79-65(Pt.2), pp 122-123) **Urinary excretion rate of ^{241}Am produced in vivo.** Toohey, R.E.; Walkup, R.E.; Larsen, R.P.; Oldham, R.D. 1979.

In Radiological and Environmental Research Division. Annual report.

The urinary excretion rates of plutonium and americium of two individuals have been determined 10,000 days after they received intravenous injections of plutonium. The results for plutonium excretion by these two cases have been published elsewhere. After the observation of ^{241}Am in bone samples from another plutonium injection case, it was decided to determine the amount of ^{241}Am present in the urine samples of these two cases and a sensitive method for the determination of ^{241}Am in the urine was developed.

ANIMALS

26422 (ANL—79-65(Pt.2), pp 124-129) **Progress report on the gastrointestinal absorption of plutonium in mice.** Larsen, R.P.; Oldham, R.D.; Bhattacharyya, M.H.; Moretti, E.S.; Austin, D.J.; Cacic, C.G. 1979.

In Radiological and Environmental Research Division. Annual report.

An investigation is being made of the effect of the oxidation state of plutonium on absorption from the gastrointestinal tract. For mice that were starved prior to gastrointestinal administration, there is no significant difference between the absorption factors for Pu(IV) and Pu(VI). The value obtained for Pu(VI) is an order of magnitude lower than that reported previously. The value obtained for Pu(IV) is two orders of magnitude higher than those reported for nitrate solutions and the same as those reported for citrate solutions.

26423 (EMSL-LV—0539-35) **Biotransport of transuranium radionuclides in dairy animals: a data summary.** Sutton, W.W.; Patzer, R.G.; Potter, G.D. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab.). Oct 1979. Contract AI08-76DP00539. 57p. NTIS, PC A04/MF A01.

In recent years, the Environmental Monitoring Systems Laboratory at Las Vegas, Nevada (EMSL-LV) has carried out a series of studies on the biological transport of plutonium, americium, neptunium, and curium in lactating dairy cattle and goats. Ruminants in general and cattle in particular form one of the more important links in the human food chain. Milk and milk products constitute a significant portion of the human diet, especially for children. This summary consists of a compilation of detailed data from a series of previously published studies. It has been prepared to present the data from all of these studies in a single source to be used by regulatory agencies in their transport modeling and hazard assessment activities. Selected source materials for the data presented in this document have been published either in the Proceedings of the Nevada Applied Ecology Group (NAEG) or as EMSL-LV publications and are listed in the References section.

26424 **Radiolabeled adrenergic neuron-blocking agents: Adrenomedullary imaging with [^{131}I]iodobenzylguanidine.** Wieland, D.M.; Wu, J.; Brown, L.E.; Mangner, T.J.; Swanson, D.P.; Beierwaltes, W.H. (Univ. of Michigan Medical Center, Ann Arbor). *J. Nucl. Med.;* **21**: No. 4, 349-353(Apr 1980).

The tissue distributions of three radioiodinated neuron-blocking agents have been determined in dogs. Iodine-125-labeled meta- and para-iodobenzylguanidines show a striking affinity for, and retention in, the adrenal medulla. Peak concentrations of the two isomers exceed those of previously reported adrenophilic compounds. High myocardial concentrations were also observed at early time intervals. Images of the dog's adrenal medullae have been obtained with para[^{131}I]-iodobenzylguanidine.

26425 **Effect of scandium on the tissue distribution of Ga-67 in normal and tumor-bearing rodents.** Hayes, R.L.; Byrd, B.L.; Rafter, J.J.; Carlton, J.E. (Oak Ridge Associated Universities, TN). Contract DE-AC05-760R00033. *J. Nucl. Med.;* **21**: No. 4, 361-365(Apr 1980).

In rats and mice the intravenous administration of scandium before or with Ga-67 produces an increase in Ga-67 excretion and bone deposition, coupled with pronounced decreases in the uptake of Ga-67 in soft tissues. These effects result from the blocking by scandium of Ga-67 plasma-protein binding sites, which forces Ga-67 into an unbound or loosely bound state. This increases Ga-67 excretion and bone deposition, which in turn acts to produce greatly reduced Ga-67 uptake in soft tissues. When tumor-bearing rats and mice are administered scandium, similar effects occur, but the uptake of Ga-67 by tumor tissue remains unchanged. This suggests that Ga-67 enters tumor and normal soft tissues by different routes. With tumor, an unbound or loosely bound form of gallium is primarily involved, whereas with normal soft tissues this route is apparently of minor importance.

26426 **Distribution and retention of ^{241}Am in the baboon.** Builmette, R.A.; Cohen, N.; Wrenn, M.E. (New York Univ., New York). *Radiat. Res.;* **81**: No. 1, 100-119(Jan 1980).

The distribution, retention, and excretion of intravenously injected ^{241}Am citrate have been investigated in a nonhuman primate. Seven adult female Kenya baboons which had been given 0.2 μCi/kg were studied for 817 days by a combination of techniques: (a) external counting of 60-keV γ of ^{241}Am in vivo in both whole-body and partial-body geometries, (b) bioassay of liver and skull biopsy samples, and (c) radioanalysis of ^{241}Am in excreta and baboon tissues at sacrifice. The data thus far confirm previously reported results that the major initial deposition sites of soluble ^{241}Am in the baboon are the skeleton [35% of the injected dose (percentage ID) a

1 day] and liver (31% ID at 1 day). The elimination rate of ^{241}Am from the liver was fairly rapid at 2.5%/day (T/sub 1/2/ = 28 days), whereas the retention of ^{241}Am in bone was long (at least several years). Americium-241 excreted during the first week after injection was detected principally in the urine, whereas the majority of Am excreted during the following 7 weeks was in feces, corresponding in the most part to elimination of Am from the liver. Microlocalization of Am in various soft tissues indicates general agreement with results previously reported for other species. However, americium in the baboon ovary at late times after injection is found as highly focalized sources, occurring principally in the outer cortical regions and associated with concretic structures. The implications of the findings of these studies with respect to metabolic parameters used for radiation dose calculations in man are discussed.

THERMAL EFFECTS

REFER ALSO TO CITATION(S) 25865, 25875, 26327, 26342, 26343, 26344, 26345, 26370

26427 (EPRI-WS—78-151) **Review and planning for aquatic cooling systems effects subprogram.** (Sigma Research, Inc., Richland, WA (USA)). Dec 1979. 317p. (CONF-7906161—). NTIS, PC A14/MF A01.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The 17 papers in this volume deal with the effects of thermal power plant cooling systems on aquatic environments. In addition, there are 3 sections dealing with current projects and state of the art, issue resolution, and recommended research. (DAD)

26428 (EPRI-WS—78-151, pp 3.135-3.145) **Biological effects of once-through cooling on Great Lakes biota.** Rasmussen, G.A. (Texas Instruments, Inc., West Chicago, IL). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

Studies were conducted on the Great Lakes where potential effects of power plant operation on the biota are recognized. Temporal and spatial variables were confined to the immediate vicinity of the discharge or to peak summer or minimal winter temperatures. The effects identified appear to be of minimal impact on the maintenance of the indigenous Great Lakes biota. (DAD)

26429 (EPRI-WS—78-151, pp 3.147-3.171) **Assessments of biological impacts of once-through cooling water systems: estuarine-sited power plants.** Loftus, M.E. (Ecological Analysts, Inc., Towson, MD). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The effects of once-through cooling systems on the biota of estuaries is described. An attempt is made to cover the variety of findings, which have been summarized according to the several biotic categories of estuaries, and to summarize the stages and types of impact assessment approaches that represent the state of the art. (DAD)

26430 (EPRI-WS—78-151, pp 3.173-3.186) **Impact analysis at marine-sited power plants.** Ginn, T.C.; Lorenzen, M.W.; Kauwling, T.J. (Tetra Tech, Inc., Lafayette, CA). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

A review is presented of environmental surveys at 28 generating stations which met the following criteria: rated generating capacity > 100 MWe; once-through cooling system; and cooling water with an annual average salinity > 28 parts per thousand. (DAD)

26431 (EPRI-WS—78-151, pp 3.187-3.190) **Summary of UWAG findings and conclusions.** Pease, T.E. (Lawler, Matusky and Skelly Engineers, Pearl River, NY). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

Methods used to measure ecological effects at power plants with once-through cooling systems are described and summarized. The types and extent (both temporal and spatial) of effects observed in these studies are summarized by biotic categories. (DAD)

26432 (EPRI-WS—78-151, pp 3.191-3.194) **Utility viewpoint.** Hogarth, W.T. (Carolina Power and Light Co., Raleigh, NC). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

Some of the problems facing utility companies today regarding environmental studies and their cost-benefit ratio are discussed. The discussion centers mainly on cooling systems and their effects on aquatic ecosystems. (DAD)

MICROORGANISMS

REFER ALSO TO CITATION(S) 25873, 26386

26433 (EPRI-WS—78-151, pp 3.113-3.134) **Review of biological effects associated with once-through cooling systems at electric power generating facilities on inland rivers and reservoirs.** Price, P. (Espey, Huston and Associates, Inc., Austin, TX). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

Biological studies performed at once-through cooled electric generating plants in the US are reviewed and assessed. Freshwater plant sites are described and a total of 264 power plants are identified. Individual studies for each major biological group are discussed. (DAD)

PLANTS

REFER ALSO TO CITATION(S) 26433

INVERTEBRATES

REFER ALSO TO CITATION(S) 25874, 26433

VERTEBRATES

REFER ALSO TO CITATION(S) 25874

26434 (EPRI-EA—1148(Vol.3)) **Evaluation of a cooling lake fishery. Volume 3. Fish population studies.** Larimore, R.W.; McNurney, J.M.; Swadener, S.O.; Buckler, J.; Waite, S.W.; Coutant, L.W. (Illinois Natural History Survey, Urbana (USA)). Dec 1979. 346p. NTIS, PC A15/MF A01.

A comparison of the fish communities of Lake Sangchris, a cooling lake, with those of Lake Shelbyville and three other Illinois reservoirs is presented. Preferred temperatures and movements of fishes were studied by radiotelemetry. Generally speaking, the populations in Lake Sangchris were similar to other reservoirs in Illinois. However, heated discharge from the power plant provided a longer growing season and different environmental conditions in part of Lake Sangchris to which several species responded favorably. Largemouth bass exhibited a greater annual growth in the heated area than elsewhere and two other species preferred the heated area during winter. Largemouth bass and carp spawned earlier in the heated area than elsewhere and white bass migrated upstream against the current produced by the power plant and spawned in the discharge canal. Mark-and-recapture estimates indicated a desirable population of largemouth bass that attracted anglers to the lake, especially in winter. There were significant biochemical genetic differences between the largemouth bass populations in Lake Shelbyville and Lake Sangchris as well as between areas of Lake Sangchris. Rate of infestation of monogenetic trematodes on bluegills in Lake Shelbyville was significantly greater than in either area of Lake Sangchris.

26435 (EPRI-WS—78-151, pp 3.51-3.68) **Evaluation of a cooling lake fishery: summary.** McNurney, J.M.; Tranquilli, J.A.; Larimore, R.W. (Illinois Natural History Survey, Urbana). Dec 1979.

From Review and planning for aquatic cooling systems effects subprogram workshop; Airlie House, VA, USA (4 Jun 1979).

The fishery of Lake Sangchris, a cooling lake in Illinois, is evaluated. The following are discussed: (1) quality and distribution of fish food resources; (2) dynamics of the fishery; and (3) a system representation in the form of a mathematical model. (DAD)

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 26327, 26342, 26343

26436 (ANL/ES—94) **Toxicities of selected substances to freshwater biota.** Hohreiter, D.W. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 68p. NTIS, PC A05/MF A01.

The amount of data available concerning the toxicity of various substances to freshwater biota is so large that it is difficult to use in a practical situation, such as environmental impact assessment. In this document, summary tables are presented showing acute and/or chronic toxicity of selected substances for various groups of aquatic biota. Each entry is referenced to its original source so that details concerning experimental conditions may be consulted. In addition, general information concerning factors modifying toxicity, synergisms, evidence of bioaccumulation, and water quality standards and criteria for the selected substances is given. The final table is a general toxicity table designed to provide an easily accessible

and general indication of toxicity of selected substances in aquatic systems.

26437 (CONF-791059—3) **Proxy methods and compounds for workplace monitoring of polynuclear aromatic hydrocarbons.** Gammage, R.B.; Bjorseth, A. (Battelle Columbus Labs., OH (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 21p. NTIS, PC A02/MF A01.

From 4. international symposium on polynuclear aromatic hydrocarbons; Columbus, OH, USA (2 Oct 1979).

A proxy compound of polycyclic aromatic hydrocarbons (PAH) is a measurable compound that represents a very large complex group of PAH compounds that are found in nearly all real life samples. In studies of biological impact, the proxy should be the limiting toxicant in terms of dose-effect. The use of benzo(a)pyrene as a direct proxy in the study of PAH compounds is evaluated. Carbon monoxide as an indicator gas for monitoring in confined areas and as a proxy compound for PAH is evaluated. A fluorescent spot test for rapidly estimating general levels of PAH in organic solvents is discussed as an indirect proxy method. A direct proxy method using a room temperature phosphorescence technique for detection of naphthalene is presented. Non-real time techniques involving chromatography and spectroscopy are also discussed. (DC)

26438 (ORNL/EIS—125) **Effects of chlorine on aquatic organisms: a review of the literature with special reference to cooling water chlorination.** Opresko, D.M. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 318p. NTIS, PC A14/MF A01.

The pre-1980 open literature on the chemistry and biological effects of chlorine in marine, freshwater, and estuarine systems is reviewed with special emphasis placed on the potential impacts of power plant chlorination practices. Information is provided on aqueous chlorine chemistry including the types and relative concentrations of residual oxidants formed under varying environmental conditions; the stability, persistence, and reactivity of these oxidants; and their potential for forming halogenated organic compounds. Analytical methods for differentiating and measuring chlorine-produced residual oxidants are discussed in a separate section. Information on biological effects, derived mainly from the results of laboratory bioassays, consists primarily of acute toxicity data, but also included are discussions of biological and environmental factors affecting species' tolerance levels; sublethal effects on reproduction, growth, behavior, and physiological processes such as respiration and osmoregulation; and possible mechanisms of oxidant toxicity at the cellular or biochemical level. The final chapter considers the relative efficiency and potential environmental impact of alternative chemical and physical methods for controlling biofouling in power plant cooling systems.

CELLS

REFER ALSO TO CITATION(S) 26399, 26401, 26403, 26443

MICROORGANISMS

REFER ALSO TO CITATION(S) 25592, 25873

26439 (DOE/EV/10127—3) **Synthetic crude oils carcinogenicity screening tests. Progress report, September 15, 1979-March 15, 1980.** Calkins, W.H.; Deye, J.F.; King, C.F.; Hartgrove, R.W.; Krahn, D.F. (Du Pont de Nemours (E.I.) and Co., Wilmington, DE (USA)). 1980. Contract AC02-78EV10127. 29p. NTIS, PC A03/MF A01.

Four crude oils (H Coal-Fuel Oil Mode, Occidental in situ Shale Oil, Exxon Donor Solvent Liquid, and SRC II) which were distilled into four fractions (naphtha, mid-distillate, gas oil and residue) for analysis and biological screening testing during the last report period were tested for mutagenicity by the Ames test and for tumor initiating activity by an initiation/promotion (skin painting) test. Substantial agreement exists between Ames and skin painting results. Low boiling naphtha fractions of the 4 crude oils showed little or no mutagenicity or tumor initiating activity by the two tests used. The higher boiling fractions (gas oils and residues) and the crude oils themselves were mutagenic and exhibited tumor initiation activity. The coal derived fractions were more active by both tests than the shale oil fractions.

PLANTS

REFER ALSO TO CITATION(S) 26394, 26445

26440 **Effect of SO_2 on sexual reproduction in Lepidium virginicum L. originating from regions with different SO_2 concentrations.** Murdy, W.H. (Emory Univ., Atlanta, GA). *Bot. Gaz. (Chicago);* **140**: No. 3, 299-309(Sep 1979).

Tolerance of SO_2 with respect to sexual reproduction is reported for populations of Lepidium virginicum from the Copper Basin of Tennessee, a region subjected to SO_2 pollution for the past 75 yr. The offspring of plants from inside and outside the Copper Basin were fumigated with 2130 $\mu g/m^3$ SO_2 for 9 h at high relative humidity in replicated experiments. As a result of SO_2 stress, plants from outside the Copper Basin were less fertile than plants from inside the Copper Basin.

INVERTEBRATES

REFER ALSO TO CITATION(S) 25874

VERTEBRATES

REFER ALSO TO CITATION(S) 25874

26441 (CONF-791059—5) **Comparison of the skin tumor-initiating activities of dihydrodiols, diol-epoxides, and methylated derivatives of various polycyclic aromatic hydrocarbons.** Slaga, T.J.; Iyer, R.P.; Lyga, W.; Secrist, A. III; Daub, G.H.; Harvey, R.G. (Oak Ridge National Lab., TN (USA); Ohio State Univ., Columbus (USA). Dept. of Chemistry; New Mexico Univ., Albuquerque (USA). Dept. of Chemistry; Chicago Univ., IL (USA). Ben May Lab. for Cancer Research). 1979. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

From 4. international symposium on polynuclear aromatic hydrocarbons; Columbus, OH, USA (2 Oct 1979).

The abilities of dihydrodiols and diol-epoxides of dibenz(a,h)anthracene [DB(a,h)A], dibenz(a,c)anthracene [DB(a,c)A], chrysene, 7-methylbenz(a)anthracene [7-MB(a)A], benzo(e)pyrene [B(e)P], and various methylated derivatives of benzo(a)pyrene [B(a)P], benz(a)anthracene [B(a)A], and 3-methylcholanthrene (3-MC) to initiate skin tumors in mice were determined. The trans-3,4-dihydrodiol of 7-MB(a)A, trans 9,10-dihydrodiol of B(e)P, and trans 1,2-dihydrodiol of chrysene were more active than their corresponding parent hydrocarbon when applied topically. The trans 3,4-dihydrodiol of DB(a,h)A had one-half of the tumor-initiating ability of DB(a,h)A. The trans 3,4-dihydrodiol of chrysene and trans 10-11-dihydrodiol of DB(a,c)A were inactive as skin tumor initiators. B(e)P-9,10-diol-11,12-epoxide, DB(a,h)A 3,4-diol-1,2-epoxide, DB(a,c)A 10,11-diol-12,13-epoxide, and 7-MB(a)A, 3,4-diol-1,2-epoxide were also inactive as tumor initiators. Chrysene 1,2-diol-3,4-epoxide had 25% of the activity of chrysene. Results show that the dihydrodiols of 7-MB(a)A, DB(a,h)A, and chrysene have moderate to high initiating activity, whereas the dihydrodiol B(e)P was inactive. The bay region diol-epoxide of chrysene was the only diol-epoxide tested that had significant activity compared to the parent hydrocarbon. Substitution of a methyl group in 7-MB(a)A, 12-MB(a)A, DMB(a)A, 3-MC, and B(a)P blocked the skin tumor-initiating activity. Likewise, substitution of a methyl group in the bay region of B(a)P and DMB(a)A decreased their tumor-initiating activity. (ERB)

26442 (DOE/METC/8087—T1) **Effects of coal combustion and gasification process contaminants on the neuromuscular system. Subtask on peripheral nervous system effects. Final report.** Franz, G.N. (West Virginia Univ., Morgantown (USA)). 1979. Contract EY-77-C-21-8087. 23p. NTIS, PC A02/MF A01.

This study is a preliminary investigation of the possible toxic effects of flyash particles from an experimental fluidized-bed combustion process at the Morgantown Energy Research Center. Emphasis has been placed on the action of trace metals present on the surface and in the matrix of the particulates emissions, since these elements may be toxic in low dosages. It is well established that external calcium (Ca^{2+}) is essential for neuromuscular transmission. In the absence of Ca^{2+} from the external medium, nerve impulses continue to invade the terminal but do not evoke transmitter release. Many of the di- and trivalent metal ions have been tested for their ability to substitute for Ca^{2+} and have been shown to affect evoked and spontaneous transmitter release. Many of these ions cause a decrease in amplitude of the evoked end-plate potential (e.p.p.), but raise the frequency of spontaneously occurring miniature end-plate potentials (m.e.p.p.s). Several investigators have found that the effective concentration necessary to cause an increase in m.e.p.p. frequency is far greater than that which decreases the e.p.p. amplitude. The neuromuscular junction of the frog was selected to test the effects of flyash particles and pure metal ions, since its general characteristics are well documented and its sensitivity to metal ions is well known. Cadmium (Cd^{2+}) was chosen for our investigation because it had previously been reported to be a highly potent inhibitor of evoked release, yet having no significant effect on spontaneous release even at high concentrations. In this report it was shown that the effective concentrations necessary to increase m.e.p.p. frequency are in the same range as those which decrease e.p.p. amplitude.

26443 **Extensive homology of nuclear ribonucleic acid and polysomal poly(adenylic acid) messenger ribonucleic acid between normal and neoplastically transformed cells.** Moyzis, R.K.; Grady, D.L.; Li,

D.W.; Mirvis, S.E.; Ts'o, P.O.P. (Johns Hopkins Univ., Baltimore, MD). Contract DOE-EY-76-S-02-3280. *Biochemistry;* **19**: No. 5, 821-832(4 Mar 1980).

A cell line, designated BP6T, derived from Syrian hamster embryo (SHE) cells following treatment with benzo[a]pyrene is capable of producing tumors in newborn hamsters following the injection of as few as 1-10 cells. Polysomal poly(A)mRNA and total nuclear RNA obtained from this highly tumorigenic cell line were compared to RNAs obtained from the nonneoplastic parental embryo cells by a variety of techniques. RNA excess hybridizations to normal cell radiolabeled single-copy DNA or to a single-copy DNA tracer enriched for sequences transcribed in neoplastically transformed cells were unable to detect any significant differences in RNA sequence complexity between normal SHE cells and neoplastic BP6T cells. This finding of extensive homology of polysomal poly(A) mRNA and total nuclear RNA between normal and neoplastic cells, together with our previous finding of extensive homology of the major ^{35}S-labeled nuclear or cytoplasmic polypeptides observable on two-dimensional gels {Leavitt, J.C., & Moyzis, R.K. (1978) J. Biol. Chem. 253, 2497-2500], demonstrates that the phenotypic changes associated with neoplastic transformation by chemical carcinogens are accompanied by relatively few changes in the qualitative pattern of gene expression in cells cultured in vitro.

26444 Partial inactivation of cytochrome c oxidase by nonpolar mercurial reagents. Mann, A.J.; Auer, H.E. (Univ. of Rochester School of Medicine, NY). *J. Biol. Chem.;* **255**: No. 2, 454-458(25 Jan 1980).

From 63. annual meeting of the Federation of American Societies for Experimental Biology; Dallas, TX, USA (2 Apr 1979).

Purified beef heart cytochrome c oxidase is inactivated to the extent of 35 to 50% by the nonpolar mercurial reagents mercuric chloride and ethylmercuric chloride. The inactivation is complete within 5 min. In titrations of activity, the plateau level of inactivation is attained at added ethylmercuric chloride:heme a ratios of about 1:1. Up to 3 mercury atoms/heme a are bound to the oxidase, although only the first of these affects its enzymatic activity. Incubation of the ethylmercury-modified oxidase with sulfhydryl compounds reverses the inactivation, with 2,3-dimercaptopropanol being most effective of the reagents tested. Spectrophotometric and polarographic assays of enzymatic activity show that K/sub m/ values for the native and the ethylmercury-modified enzymes are practically indistinguishable, and that the partial inactivation observed for the latter is reflected exclusively in a lower value of V/sub max/ compared to that of the native enzyme. Based on these results, we propose that ethylmercuric chloride reacts with a single crucial--SH group per heme a, and that electron transfer processes in the modified product are partially inhibited.

MAN

REFER ALSO TO CITATION(S) 25282

26445 (ANL—79-65(Pt.2), pp 131-132) **Application of radiolead to metabolic studies.** Holtzman, R.B. 1979.

In Radiological and Environmental Research Division. Annual report.

A review is presented of the literature through 1977 on the uses of radioactive lead isotopes in metabolic studies in man, animals, and plants. These studies have been done mainly with the naturally-occurring, long-lived (22-yr half life) ^{210}Pb, but a few were with 53-hr ^{203}Pb or 10.6-hr ^{212}Pb. Such studies have made possible estimates of the metabolic parameters of lead in man and animals, such as intestinal absorption, the ratio of fecal-to-urinary excretion of endogenous lead, residence time of lead in the body and in various organs, and the distribution in the body (skeleton, liver, kidney, and blood). Subsequently, these parameters and data have been used to trace the sources of lead for man, such as those from the atmosphere, food, cigarette smoke, and automobile exhaust.

26446 (BNL—27681) **In vivo measurement of critical level of kidney cadmium. Dose effect studies in cadmium smelter workers.** Ellis, K.J.; Morgan, W.D.; Zanzi, I.; Yasumura, S.; Vartsky, D.; Cohn, S.H. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Brooklyn (USA). Downstate Medical Center). 1980. Contract EY-76-C-02-0016. 23p. (CONF-800372—1). NTIS, PC A02/MF A01.

From 2. annual Park City environmental health conference; Park City, UT, USA (27 Mar 1980).

Portions of document are illegible.

It is generally accepted that the critical organ for exposure to cadmium is the kidney. Considerable attention has been devoted to estimates of the maximum level of cadmium that can be sequestered in human kidneys before overt renal damage occurs. This threshold value is referred to as the critical concentration. In order to obtain more data on the dose-effect relationship of cadmium deposition in human beings, a study was undertaken of occupationally exposed workers at a cadmium production plant. The in vivo measurements of kidney and liver cadmium are the major focus of this study and provide the basis for estimating the critical concentration of renal cadmium.

26447 (BNL—27912) **Cytogenetic bases for risk inference.** Bender, M.A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 11p. (CONF-800601—1). NTIS, PC A02/MF A01.

From 13. Rochester international conference on environmental toxicity--measurement of risks; Rochester, NY, USA (2 Jun 1980).

Various enviromental pollutants are suspected of being capable of causing cancers or genetic defects even at low levels of exposure. In order to estimate risk from exposure to these pollutants, it would be useful to have some indicator of exposure. It is suggested that chromosomes are ideally suited for this purpose. Through the phenonema of chromosome aberrations and sister chromatid exchanges (SCE), chromosomes respond to virtually all carcinogens and mutagens. Aberrations and SCE are discussed in the context of their use as indicators of increased risk to health by chemical pollutants. (ACR)

26448 Benzo(a)pyrene uptake by human plasma lipoproteins in vitro. Shu, H.P.; Nichols, A.V. (Univ. of California, Berkeley). *Cancer Res.;* **39**: 1224-1230(Apr 1979).

Benzo(a)pyrene distribution between plasma and red blood cells was estimated following sedimentation of red blood cells. Benzo(a)pyrene distribution in the major lipoprotein fractions was determined following ultracentrifugal fractionation of plasma. Greater than 70% of benzo(a)pyrene in whole blood partitioned into plasma. Of the benzo (a) pyrene in plasma, less than 5% partitioned into the bulk of the plasma proteins (d > 1.21 g/ml), while more than 95% partitioned into the plasma lipoproteins (d < 1.21 g/ml). The distribution of benzo(a)pyrene in normolipoproteinemic plasma was 29% in very-low-density (d < 1.006 g/ml), 57% in low-density (d 1.006 to 1.063 g/ml), and 10% in high-density (d 1.063 to 1.21 g/ml) lipoproteins. The percentage of benzo(a)pyrene distribution among lipoprotein fractions was independent of the level of benzo(a)pyrene taken up by plasma. It was also independent of whether the incubation studies were conducted with total plasma subsequently fractionated into lipoprotein fractions or with isolated lipoprotein fractions themselves, which yielded a calculated percentage of distribution. These findings are discussed with respect to (a) the use of the uptake data to estimate percentage of benzo(a)pyrene distribution for other plasmas, (b) factors which may govern benzo(a)pyrene distribution in plasma of intact animals, (c) the possible relationship in the intact animal between lipoprotein and benzo(a)pyrene turnover, and (d) the possible role of lipoproteins in cellular uptake of benzo(a)pyrene.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

26449 (JPRS—75515) **USSR report: life sciences, No. 1. Effects of nonionizing electromagnetic radiation.** 17 Apr 1980. Translation of various papers. 60p. NTIS.

Translation of articles from USSR journals on the effects of nonionizing electromagnetic radiation are presented. Microwave radiation is included. Effects studied range from the subcellular level to epidemiological surveys. Separate abstracts were prepared for 5 of the 12 papers. The other 7 papers are represented by abstracts only in the publication. Two book reviews are also included dealing with the hygienic and metabolic effects of electromagnetic fields. (ACR)

26450 (JPRS—74576) **USSR report: biomedical and behavioral sciences, No. 125. Effects of nonionizing electromagnetic radiation.** 15 Nov 1979. Translation of various papers. 53p. NTIS.

Separate abstracts were prepared for four of the seven articles presented in this issue of the journal. Included among the other three articles is a full length article on Niemr resonance phenomena and two abstracts of articles on effects of SHF fields on muscle oxygen tension and temperature in rats adapted to hypoxia, and sensitivity thresholds of wheat stems and roots to magnetic fields. (ERB)

26451 (JPRS—74576, pp 1-11) **Survey of effects of continuous and alternating low-frequency magnetic fields.** Bogolyubov, V.M.; Skurikhina, L.A. (Central Inst. of Health Resort Medicine and Physical Therapy, Moscow, USSR). 15 Nov 1979. Translated from Vopr. Kurortol., Fizioter. Lech. Kul't.; No. 6, 64-69(1978). NTIS.

In USSR report: biomedical and behavioral sciences, No. 125. Effects of nonionizing electromagnetic radiation.

The action of the MF on the organism is connected with the initial physicochemical processes developing during absorption - the interaction of their energy with the tissues. The possibility of three physical phenomena occurring during the process is accepted. A CMF inhibits the development of conditioned reflexes in rats, the

latent period of the reaction increasing while its frequency decelerated. Shifts in the coagulation system of blood vary in dependence on the duration and intensity of the action of the MF. After a single exposure to an MF, changes of a pathological but not catastrophic nature arise in a number of organs and systems of intact animals. These changes are most pronounced and stable in the sex glands. Disturbances in blood- and lymph-circulation are detected macroscopically. In the nerve cells productive-dystrophic disturbances of the neuroglia, swelling, and vacuolization of the nuclei and cytoplasm in some ganglionic cells are demonstrated microscopically. In the lungs, emphysema and the concentration of polysaccharides are found. Destructive changes in the hepatocytes are detected in the liver. In the kidneys widespread necrosis and desquamation of the epithelium are observed. Concentration of eosinophiles is found in bone marrow and in the sex organs, part of the tubules are filled with the detritus of disintegrating cells. In the tissues of the eye hyperemia of the sclera, edema, disturbance of lymph circulation, change in the epithelium of the lens, and necrobiosis of the ganglionic cells are observed. The morphological changes are significantly more pronounced with exposure to pulsed and alternating MF's than to CMF. (ERB)

26452 (JPRS—74576, pp 28-33) **Influence of a low frequency (50 Hz) electric field on the organism.** Gabovin, R.D.; Kozyarin, I.P. (Kiev Medical Inst., USSR). 15 Nov 1979. Translated from Gig. Sanit.; No. 1, 11-15(1979). NTIS.

In USSR report: biomedical and behavioral sciences, No. 125. Effects of nonionizing electromagnetic radiation.

The results of investigations conducted on animals during a 30-min daily exposure to electric fields of industrial frequency are presented. Rats of group 1 served as the control and the animals of groups 2, 3, and 4 were exposed daily for 4 months to an electric field with intensities of 7, 12, and 15 kV/m, respectively. In the experiment no signs of deviation were registered in behavioral reactions and the body mass of animals of all test groups from the control. Ability to work of animals of groups 2 and 3 did not change, but in animals of group 4, it decreased. In the study of the functional state of the nervous system, very early shifts in comparison with the control were observed in the values of the summation-threshold indicators and the time of the unconditioned reflex latent period. Dynamic observation of the blood cholinesterase activity revealed a temporary increase in animals of groups 2 and 3 in the second and third months of irradiation, whereas in animals of group 4 an increase was observed from the second month and before the end of the experiment. Changes of the functional state of the nervous system were reflected to a certain degree also in metabolic processes. Thus, in animals exposed to intensities of 12 and 15 kV/m, a reliable rise of the residual nitrogen, urea, and glucose in the blood was observed. At the end of the experiment a reliable reduction of the glycogen content in the liver was registered in animals of the test groups. The immunological reactivity of the experimental animals was also judged. In animals of the test groups, an intensification of degranulation of the basophilic leukocytes was observed. In the same animals intensification of the Ierne-Klemparskaya reaction was also observed. Also studied were the balance and interorgan exchange of a number of trace elements: copper, molybdenum, iron, and manganese. Brief daily irradiation of the animals caused reliable changes in the metabolism of trace elements. (ERB)

26453 (JPRS—74576, pp 34-41) **Low frequency dielectric dispersion of biological tissues.** Levchuk, Yu.N.; Dyshlovoy, V.D. 15 Nov 1979. Translated from Elektron. Obrab. Mater.; No. 3, 69-73(1979). NTIS.

In USSR report: biomedical and behavioral sciences, No. 125. Effects of nonionizing electromagnetic radiation.

Within the framework of the Debye theory, calculations have been made of the low-frequency dielectric parameters of several biological tissues. Results of the calculations are compared with an experiment based on available literature data. The inadequacy of the Debye polarization theory and the Maxwell-Wagner polarization theory to explain the dialectric properties of living tissues has been shown. It has been shown by calculation that the energy of a homogeneous electromagnetic field, when absorbed in various organs of the human body, is approximately equal. Ways are noted for experimental study of low-frequency dielectric dispersion of biological objects, taking into account the features of the dispersion.

26454 (JPRS—74576, pp 42-46) **Influence of electrostatic fields on respiratory enzymes.** Mkrtchyan, S.L. (State Medical Inst., Erevan, USSR). 15 Nov 1979. Translated from Biol. Zh. Arm.; No. 2, 157-161(1979). NTIS.

In USSR report: biomedical and behavioral sciences, No. 125. Effects of nonionizing electromagnetic radiation.

The activity of enzymes and intermediates of the respiratory chain of the hepatic mitochondria of rats was investigated after exposure to an electrostatic field. A decrease in succinate dehydrogenase and succinate-cytochrome-s-reductase activity and activation of cytochrome oxidase following 24-hour and one-week exposure and of succinate dehydrogenase activity after one-hour of exposure were demonstrated. A comparative analysis of the results obtained and the data of polarographic investigation was performed. The role of hyperoxia arising in tissues as the result of the influence of the electrostatic field in the mechanism of the described changes is discussed, as well as the possibility of the direct action of the field on the molecules of the enzymes.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26316

26455 (CONF-800403—41) **Energy risk analysis and data collection.** Hoy, H.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From ANS thermal reactor safety meeting; Knoxville, TN, USA (8 Apr 1980).

In comparing the occupational risks for the various conventional and emerging, or nonconventional, energy technologies, many basic data sources are used, for example, Mine Safety and Health Administration, Occupational Safety and Health Administration, Bureau of Labor Statistics, National Safety Council, Department of Transportation, Railway Transportation Administration, US Coast Guard, Department of Energy, etc. However, since the various data systems collect data for their own specific purposes, great care must be taken to ensure that the data and risk analysis criteria are indeed applicable to the concerned technology and that the data can be normalized to the same basic unit before comparisons are made. The danger of using incomplete data or data collected in only one area is illustrated, and it is demonstrated that use of inadequately evaluated data can lead to errors of factors of 3 to 5. 4 figures, 3 tables.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 25304, 25313, 25332, 25334, 25335, 25397, 25398, 25399, 25400, 25409, 25412, 25419, 25421

26456 (UCRL—82649) **Simplified groundwater flow modeling: an application of Kalman filter based identification.** Pimentel, K.D.; Candy, J.V.; Azevedo, S.G.; Doerr, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 13p. (CONF-7909138—1). NTIS, PC A02/MF A01.

From International Federation of Information Processing working conference on simulation and the environment; Bangor, UK (18 Sep 1979).

The need exists for methods to simplify groundwater contaminant transport models. Reduced-order models are needed in risk assessments for licensing and regulating long-term nuclear waste repositories. Such models will be used in Monte Carlo simulations to generate probabilities of nuclear waste migration in aquifers at candidate repository sites in the United States. In this feasibility study we focused on groundwater flow rather than contaminant transport because the flow problem is more simple. A pump-drawdown test is modeled with a reduced-order set of ordinary differential equations obtained by differencing the partial differential equation. We determined the accuracy of the reduced model by comparing it with the analytic solution for the drawdown test. We established an accuracy requirement of 2% error at the single observation well and found that a model with only 21 states satisfied that criterion. That model was used in an extended Kalman filter with synthesized measurement data from one observation well to identify transmissivity within 1% error and storage coefficient within 10% error. We used several statistical tests to assess the performance of the estimator/identifier and found it to be satisfactory for this application.

GEOPHYSICS

REFER ALSO TO CITATION(S) 25410

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 25406

GEOPHYSICAL SURVEY METHODS

26457 (UCRL—15233) **Role of radiation damping in the impedance function approach to soil-structure interaction analysis.** (NCT Engineering, Inc., Lafayette, CA (USA)). May 1980. Contract W-7405-ENG-48. 51p. NTIS, PC A04/MF A01.

This report was prepared at the request of the Lawrence Livermore Laboratory (LLL) to provide background information for analyzing soil-structure interaction by the frequency-independent impedance function approach. LLL is conducting such analyses as part of its seismic review of selected operating plants under the Systematic Evaluation Program for the US Nuclear Regulatory Commission. The analytical background and basic assumptionsof the impedance function theory are briefly reviewed, and the role of radiation damping in soil-structure interaction analysis is discussed. The validity of modeling soil-structure interaction by using frequency-independent functions is evaluated based on data from several field tests. Finally, the recommended procedures for performing soil-structure interaction analyses are discussed with emphasis on the modal superposition method.

26458 (UCRL—84091) **Application of digital image analysis techniques to the Geyser's data and topography.** Porch, W.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 May 1980. Contract W-7405-ENG-48. 16p. (CONF-800480—2). NTIS, PC A02/MF A01.

From ASCOT program planning meeting; Gettysburg, PA, USA (15 Apr 1980).

This paper describes the results of digital image analysis and techniques applied to acoustic sounder data and topographic relief in the Geyser's region. The two dimensional fast Fourier transform (2DFFT) represents the spacial variability of a photographic image. The spacial variability of topography in complex terrain can be represented in this way and insight into degree of complexity and dominating spacial wavelengths can be gained. This was performed for a 16 km square digitized topographic map of the Geyser's region with 63.5 m resolution. It was also of interest to compare facsimile recordings of acoustic sounder data to optical turbulence measurements.

26459 **Computerized geophysical tomography.** Dines, K.A.; Lytle, R.J. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Proc. IEEE ;* 67: No. 7, 1065-1073(Jul 1979).

Computerized tomography is used as an aid in geophysical exploration. With this method, detailed pictures of electromagnetic properties in the regions between pairs of boreholes can be reconstructed. The spatial distribution of attenuation or propagation velocity is calculated from line integrals along rays in the plane between boreholes, and displayed as a digital picture. In principle, the transmission of seismic data can also be analyzed by this method as long as it obeys the line integral model. Iterative solution techniques, similar to those used in medical x-ray tomography are applied to solve the large sets of linear equations relating the line integral data and the remote observables. A straight-line ray optics model was used for energy propagation between boreholes. The performance of the reconstruction algorithm is demonstrated using computer-generated data and it is then applied to experimental data collected by continuous-wave electromagnetic transmission probing. Experimental attenuation reconstructions are presented of a proposed underground urban mass-transit site. Both lateral and vertical variations are displayed using these methods.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 25328, 25385, 25396, 25407, 25408, 25414, 25422, 25424

26460 (LA-UR—80-204) **Rock alteration in an experimentally imposed temperature gradient.** Charles, R.W. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800718—1). NTIS, PC A02/MF A01.

From 3. international symposium on water-rock interaction; Edmonton, Alberta, Canada (14 Jul 1980).

Rock alteration in a dynamic (circulating) hydrothermal system can be applied to any geologic system with mobile fluids. Some examples are geothermal energy extraction, ore mineral extraction, and radioactive waste isolation. While isothermal systems yield important results, polythermal (i.e., temperature gradient) systems more closely model reactions of fluid moving through a rock reservoir. The above examples will generally involve temperature gradients across the rock reservoir. A controlled temperature gradient circulation system was developed to help define these rock-fluid reactions. Six fine grained prisms are placed along the axis of a 113 cm pressure vessel. The prisms are at 72, 119, 161, 209, 270, and 310°C under flow conditions of 4 cc/min. at 1/3 kbar total pressure. In this experiment a granodiorite was reacted with initially distilled water.

26461 **Ultrasonic propagation in Solenhofen limestone at high pressures.** Fritz, I.J. (Sandia Labs., Albuquerque, NM). *Geophysics;* 43: No. 5, 1014-1017(Aug 1978).

The phase transitions in pure calcite which is the main constituent of limestone, occur at 14.5 kbar (calcite I-II) and 17.4 kbar (calcite II-III). To characterize the effect of the II-III transition on sound propagation in limestone, measurements were made to 25 kbar on Solenhofen limestone. Both longitudinal and transverse velocities were measured over the full pressure range; thus, the measurements represent the first study of the effect of the II-III transition on shear wave propagation under conditions of hydrostatic pressure. Data were obtained on both jacketed and unjacketed samples at 5 and 10 MHz, respectively. The results on the unjacketed samples are emphasized because the anomalies due to the phase transitions are sharper and more pronounced in this case. Anomalies were noted for both transverse and longitudinal waves. 3 figures. (RWR)

26462 **Natural zeolites: occurrence, properties, and use.** Sand, L.B.; Mumpton, F.A. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978). 557p. (CONF-760626—(Exc.)).

From Zeolite conference; Tucson, AZ, USA (6 Jun 1976).

This volume consists of papers selected from those presented at ZEOLITE '76, an international conference on the occurrence, properties, and utilization of natural zeolites. The objective is to serve as a useful, basic reference in the field of natural zeolites. Topics covered include crystal structure and mineralogy, geology and occurrences, physical and chemical properties, and applications. (ACR)

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 25302, 26206

26463 **Ion-exchange equilibria between montmorillonite and solutions of moderate-to-high ionic strength.** Shiao, S.Y. (Oak Ridge National Lab., TN); Rafferty, P.; Meyer, R.E.; Rogers, W.J. *ACS Symp. Ser.;* No. 100, 297-324(1979).

Prediction of the migration rates of ions in geologic formations is of extreme importance in the fields of nuclear waste disposal and enhanced oil recovery. In order to accumulate a systematic body of information pertinent to interest on minerals typical of classes, from a wide range of aqueous solution compositions. Initially, montmorillonite was selected for attention because its high adsorptive capacity for ions may cause it to dominate the adsorptive proportion of the formation in which it is present. Reported here are distribution coefficients of alkali metal and alkaline earth ions, and of one rare earth, between montmorillonite predominantly in the sodium and calcium forms and aqueous solutions of controlled pH, at moderate to high salinities (> 0.01 M NaCl).

OCEANOGRAPHY

26464 **Description of nonlinear internal wave interactions using Langevin methods.** Pomphrey, N.; Meiss, J.D.; Watson, K.M. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Geophys. Res.;* 85: No. C2, 1085-1094(20 Feb 1980).

A comparison is made between several methods for calculating energy transport among the linear normal modes of the internal wave field. Two Langevin techniques are presented. The first is based on the Fluctuation-dissipation theorem and provides a relaxation rate v/sub F/ and a transport equation. The second method is an application of the Krylov-Bogoliubov-Mitropolsky perturbation theory and provides a Langevin rate constant v/sub p/ calculated here only to lowest order. The two formulations are closely related to the radiative transfer (Boltzmann) equation, whose rate is the difference between V/sub F/ and V/sub p/. Computations confirm the conclusion of McComas and Bretherton that the GM-76 spectrum is approximately a steady state spectrum for three-wave interactions except for frequencies near the inertial frequency and at the lowest vertical modenumbers. The sensitivity of V/sub F/ and V/sub p/ to spectra form is also discussed. Simple analytic expressions for the rates are derived for the induced diffusion, elastic scattering, and parametric subharmonic instability mechanisms. The first of these expressions provides a useful fit to the full computation over much of the spectrum. Finally, net energy flow in the nonequilibrium portion of the GM-76 spectrum is discussed.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

REFER ALSO TO CITATION(S) 26206

26465 (CONF-7905143—) **Workshop on Satellite Power Systems (SPS) effects on optical and radio astronomy.** Stokes, G.M.; Ekstrom, P.A. (eds.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. EY-76-C-06-1830. 273p. NTIS, PC A12/MF A01.

From Workshop on satellite power systems effect on optical and radio astronomy; Seattle, WA, USA (May 1979).

The impacts of the SPS on astronomy were concluded to be: increased sky brightness, reducing the effective aperture of terrestrial telescopes; microwave leakage radiation causing erroneous radioastronomical signals; direct overload of radioastronomical receivers at centimeter wavelengths; and unintentional radio emissions associated with massive amounts of microwave power or with the presence of large, warm structures in orbit causing the satellites to appear as individual stationary radio sources; finally, the fixed location of the geostationary satellite orbits would result in fixed regions of the sky being unusable for observations. (GHT)

COSMIC RADIATION

26466 **Restriction of cosmic-ray acceleration, mechanisms by high-energy Be^7/Be data.** Orth, C.D.; Buffington, A.; Mast, T.S. (Space Sciences Laboratory and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *AIP Conf. Proc.;* **56**: No. 1, 239-242(Nov 1979).

New high-energy cosmic-ray Be data indicate that the ratio Be^7/Be drops by approximately a factor of two between 200 and 1500 MeV/nucleon. This result may provide a severe constraint for theories of cosmic-ray acceleration.

STARS

26467 (UCRL—84354) **Late time optical spectra from the Ni^{56} model for Type I Supernovae.** Axelrod, T.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1980. Contract W-7405-ENG-48. 17p. (CONF-800370—1). NTIS, PC A02/MF A01.

From Supernova type I workshop; Austin, TX, USA (17 Mar 1980).

A numerical model has been created that produces self-consistent optical spectra, temperatures, and ionization states for a homologously expanding spherical shell which at $t = 0$ is assumed to consist of pure Nickel 56, and is further assumed to have density independent of radius within the shell. A brief summary is given of the model, followed by some results from the calculations. (GHT)

26468 **Equation of state near β equilibrium for a collapsing stellar core.** Murphy, m.J. (Physics Division, Argonne National Laboratory, Argonne, Illinois;). *Astrophys. J., Suppl. Ser.;* **42**: No. 3, 385-420(Mar 1980).

The composition and equation of state for the collapsing core of a massive star are calculated for temperatures in the range 5×10^9 to 5×10^{11} K and densities in the range 5×10^{10} to 5×10^{13} g cm^{-3}. The core is approximated by a noninteracting gas, incorporating free nucleon degeneracy, high degrees of neutronization, and the thermal excitation of nuclei. The conditions prior to and at high degrees of neutronization, and the thermal excitation of nuclei. The conditions prior to and at β equilibrium are calculated, and analytic expressions for the inhibition of the electron capture rates by neutrino degeneracy are obtained. An estimate of probable collapse trajectories provides a general picture of core conditions during dynamical collapse. The results include a comparison of the effects of a Fermi gas partition function for the nuclei, and another form for the partition function which saturates at $kT \approx 10$ MeV. The two approaches yield nearly identical results along the collapse trajectories, implying that the partition of nuclear states for heavy nuclei has a negligible role in the equation of state for $kT > 10$ MeV. For $kT <$ or ≈ 5 MeV, the thermal excitation of nuclei pulls the adiabatic index below 4/3. It is also found that simple approximations to the nuclear composition do not work very well along the projected trajectories.

26469 **Stellar weak-interaction rates for sd-shell nuclei. I. Nuclear matrix element systematics with application to ^{26}Al and selected nuclei of importance to the supernova problem.** Fuller, G.M.; Fowler, W.A.; Newman, M.J. (W. K. Kellogg Radiation Laboratory, California Institute of Technology). *Astrophys. J., Suppl. Ser.;* **42**: No. 3, 447-473(Mar 1980).

Astrophysical positron emission, continuum electron capture, and neutrino energy loss rates are calculated for $^{26}Al \rightarrow {}^{26}Mg$, $^{30}P \rightarrow {}^{30}Si$, $^{31}S \rightarrow {}^{31}P$, $^{32}S \rightarrow {}^{32}P$, $^{33}S \rightarrow {}^{33}P$, and $^{35}Cl \rightarrow {}^{35}S$. Measured nuclear level information and matrix elements are used where available. Unmeasured matrix elements for allowed transitions are assigned on the basis of simple shell model arguments and the results of detailed large-scale shell model calculations by Wildenthal and his collaborators. The experimentally determined matrix elements are found to dominate the rates over most of the range of temperatures and densities considered. The uncertainties in the rates are estimated. Appropriate average matrix elements for unmeasured Gamow-Teller transitions are estimated for use in other sd-shell nuclei. The rates presented agree roughly with those of Hansen over a wide range of conditions, but potentially important difference in the rates exist at temperatures and densities relevant for the production and destruction of ^{26}Al and for neutronization and neutrino loss in the late stages of presupernova evolution.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

26470 **Detection of a fast, intense and unusual gamma-ray transient.** Cline, T.L.; Desai, U.D.; Pizzichini, G.; Teegarden, B.J.; Evans, W.D.; Klebesadel, R.W.; Laros, J.G.; Hurley, K.; Niel, M.; Vedrenne, G.; Estoolin, I.V.; Kouznetsov, A.V.; Zenchenko, V.M.; Hovestadt, D.; Gloeckler, G. (Laboratory for High Energy Astrophysics, Goddard Space Flight Center). *Astrophys. J., Lett. Ed.;* **237**: No. 1, L1-L5(1 Apr 1980).

An unusual transient pulse of $>$ or ≈ 50 keV photons was detected on 1979 March 5 by the γ-ray burst sensor network using nine space probes and satellites. Its characteristics are unlike those of the known variety of γ-ray bursts and therefore suggest that it was formed either by a completely different origin species or in a very different manner. In a companion Letter it is identified with the LMC supernova remnant N49.

26471 **Location of the gamma-ray transient event of 1979 March 5.** Evans, W.D.; Klebesadel, R.W.; Laros, J.G.; Cline, T.L.; Desai, U.D.; Pizzichini, G.; Teegarden, B.J.; Hurley, K.; Niel, M.; Vedrenne, G.; Estoolin, I.V.; Kouznetsov, A.V.; Zenchenko, V.M.; Kurt, V.G. (University of California, Los Alamos Scientific Laboratory). *Astrophys. J., Lett. Ed.;* **237**: No. 1, L7-L9(1 Apr 1980).

The 1979 March 5 gamma event (Cline et al.; Mazets et al.; Barat et al.) was observed by gamma burst instruments on nine widely separated spacecraft. Analysis of the event arrival times has yielded a redundantly determined 1′ x 2′ error box centered at R.A. = 5/sup h/25/sup m/95, decl. = -66 °07′. 1 (equinox 1950.0). Located within the box is N49, a supernova remnant in the LMC. If N49 was the source of the transient, then the peak γ-ray and hard X-ray luminosity was 10/sup 44-45/ ergs s^{-1}, and the total radiated energy was 10/sup 43-44/ ergs. Although the statistical arguments in favor of identification with N49 are strong, some of the event characteristics: e.g., the combination of high intensity and fast rise time: seem to be more easily explainable in terms of a foreground object.

GALAXIES

26472 (UCRL—52946) **Numerical study of rotating interstellar clouds: equilibrium and collapse.** Norman, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 231p. NTIS, PC A11/MF A01.

Thesis.

Equilibrium and collapse of rotating, axisymmetric, idealized interstellar gas clouds is calculated with a 2D hydrodynamics code. The hydrodynamics features an improved angular momentum advection algorithm. Angular momentum is advected consistently with mass by deriving angular momentum fluxes from mass fluxes and the local distribution of specific angular momentum. Local conservation is checked by a graph of mass versus specific angular momentum for the cloud as a whole.

26473 (UCRL—84410) **Computational astrophysics relating to the interstellar medium: problems and prospects for the 1980's.** Woodward, P.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 8p. (CONF-800236—1). NTIS, PC A02/MF A01.

From Conference on computational astrophysics; Hampton, VA, USA (Feb 1980).

The general goal of research on the interstellar medium is to understand the structure and dynamics of the interstellar gas. This subject is important for three reasons. First, the classic tracers of the spiral structure of galaxies are related directly to the gaseous component of galactic disks. Therefore an understanding of the dynamics of the gas is essential in interpreting observations of spiral galaxies. Second, radio continuum observations relate to the magnetic field, which is frozen into the gas under most circumstances. Hence these observations must be interpreted using magnetohydrodynamic models. Third, the initial conditions for star formation are determined by the structure and dynamics of the interstellar gas. In this way gas dynamics plays an essential role in understanding the relative numbers of binary and single stars, the formation of planetary systems, and even the evolution of the stellar content of galaxies.

COSMOLOGY

26474 New approach to cosmological theory. Dirac, P.A.M. (Florida State Univ., Tallahassee). pp 1-16 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

An approach to cosmological theory is described wherein time is measured in two ways, atomic time (t) used for atomic processes governed by quantum laws and mechanical time (tau) used with classical laws for the motion of bodies. These are related by tau = log t. (GHT)

PLANETARY PHENOMENA

26475 Difficulty with Ne^{22} as the neutron source for the solar system s-process. Despain, K.H. (Department of Astronomy, Haverford College). *Astrophys. J., Lett. Ed.;* **236**: No. 3, L165-L168(15 Mar 1980).

A consideration of the Ne^{22} neutron source as it operates in shell flashes suggests that it cannot produce the bulk of the solar system s-process elements. Shell flashes at low core masses do not liberate enough neutrons per flash to build up solar abundances, while flashes at high core masses liberate the neutrons too rapidly. Classical s-process branches appear to be saturated by neutron capture and many r-process elements are produced. The resulting isotope ratios would be distinctly nonsolar.

26476 Reaction Mg(n, α)Ne at 14.1 and 14.7 MeV: cross sections and implications for meteorites. Reedy, R.C. (Los Alamos Scientific Lab., NM (USA)); Herzog, G.F.; Jessberger, E.K. (Max-Planck-Institut fuer Kernphysik, Heidelberg (Germany, F.R.)). *Earth Planet. Sci. Lett.;* **44**: No. 2, 341-348(Aug 1979).

Mass spectrometric analyses of neutron-irradiated targets of natural magnesium yield cross sections of 59 +- 14, 160 +8, and 11.0 +- 3.3 mb for ^{20}Ne, ^{21}Ne, and ^{22}Ne, respectively, at 14.1 MeV and of 94 +- 8, 152 +- 12, and 13.0 +- 2.0 mb at 14.7 MeV. With the incorporation of these cross sections, calculations modeling cosmic-ray interactions in stony meteoroids of radii 20 and 26 cm predict that between the surface and center the $^{22}Ne/^{21}Ne$ ratio falls more than 10% while the ^{21}Ne production rate rises about 30%. The reaction $^{24}Mg(n, \alpha)^{21}Ne$ predominantly controls these trends: the $^{22}Ne/^{21}Ne$ ratio due to magnesium decreases over 15% while that due to silicon remains constant with increasing depth. The calculations are compared with published neon measurements for the Keyes and St. Severin meteorites.

ATMOSPHERIC PHYSICS

MAGNETOSPHERIC PHENOMENA

26477 Comparison between the 30- to 80-keV electron channels at ATS 6 and 1976-059A during conjunction and application to spacecraft charging prediction. Garrett, H.B.; Schwank, D.C.; Higbie, P.R.; Baker, D.N. (Air Force Geophysics Laboratory, Hanscom Air Force Base, Bedford, Massachusetts 01731). *J. Geophys. Res.;* **85**: No. A3, 1155-1162(1 Mar 1980).

The ATS 6 satellite, during an orbital maneuver in September 1976, passed within a few hundred kilometers of the geosynchronous satellite 1976-059A. Analysis of the 30- to 80-keV electron data from the University of California at San Diego (UCSD) electrostatic analyzers on ATS 6 and the 30- to 300-keV electron data from the Los Alamos Scientific Laboratory instrument on 1976-059A during this period reveals good agreement between the two instruments even when the separation is +- 7°. The low-energy UCSD ion data from ATS 6 allow a simultaneous determination of the potential difference between ATS 6 and th ambient medium. Use of the 1976-059A electron data to approximate the ambient plasma electron density and temperature during these charging periods indicates sufficient information exists in order to estimate the maximum potentials to which ATS 6 charges in sunlight an eclipse. As data from 1976-059A and similar satellites are potentially available in real time, the information therefore exists to create a satellite charging index for the geosynchronous regime that would be valid within at least +- 7° longitude of the position of each measurement.

26478 Ion acceleration at the earth's bow shock: A review of observations in the upstream region. Gosling, J.T.; Asbridge, J.R.; Bame, S.J.; Feldman, W.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *AIP Conf. Proc.;* **56**: No. 1, 81-99(Nov 1979).

Positive ions are accelerated at or near the earth's bow shock and propagate into the upstream region. Two distinctly different population of these ions, distinguished by their greatly different spectral and angular widths, can be identified there. The type of ion population observed in the upstream region is strongly correlated with the presence or absence of long-period compresive waves in the solar wind. Very few ions are accelerated in the vicinity of the shock to energies much above about 100 keV. It is not yet clear whether the most energetic ions (i.e. those near 100 keV) are accelerated at the shock or in the broad disturbed region upstream from the shock. In either case stochastic acceleration by turbulent electrostatic fields seems to be the most viable candidate for the acceleration of the most energetic particles.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

26479 High resolution infrared absorption spectra of BCl_3 and BCl_2F dissolved in solid argon and solid krypton. Maier, W.B. II; Holland, R.F. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **72**: No. 12, 6661-6677(15 Jun 1980).

High-resolution (≈0.035 cm^{-1}) infrared absorption spectra of BCl_3 and BCl_2F dissolved in solid argon and krypton have been obtained. The solids were grown from liquid solutions, were 1.4 cm thick, and were reasonably clear optically. The ν_2, ν_3, $\nu_1+\nu_4$, $\nu_2+\nu_4$, $\nu_1+\nu_3$, and $2\nu_3$ bands of BCl_3 were found, and the positions of the ν_1 and ν_4 bands of BCl_2F were inferred. An observed perturbation of the ν_2 band of $^{10}BCl_3$ is explained by invoking a lattice-induced distortion of BCl_3 from planarity. The observed spectral lines are very narrow, so the absorption bands of different boron and chlorine isotopomers are well resolved. The observed full spectral width of the absorption lines at half maximum absorbance is <0.04 cm^{-1} for the ν_2 lines of BCl_3 and ~ 0.08 cm^{-1} for the other fundamentals. The wave number nu-tilde of a given line depends on solid solvent and on temperature T; dnu-tilde/dT is within the range $0.014<$ or $=$dnu-tilde $<$ or $=0.09$ $cm^{-1}/°C$ for all bands. Anharmonicities and harmonic frequencies have been obtained from the data, and the anharmonicity constants lie between -1.8 and 0.8 cm^{-1}. Energies have been estimated for the first excited states of the ν_1 and ν_4 modes of BCl_3 and also for the A'_1 and A'_2 levels of the $\nu_3=\nu_4=1$ state of BCl_3. The usual theory of harmonic oscillators having D/sub 3h/ symmetry does not adequately describe the ν_3 and ν_4 band positions and isotopic splittings.

26480 Properties of vibrational energy levels in the quasi periodic and stochastic regimes. Noid, D.W.; Koszykowski, M.L.; Tabor, M.; Marcus, R.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37870). *J. Chem. Phys.;* **72**: No. 11, 6169-6175(1 Jun 1980).

Several aspects of the quantal energy spectrum are explored for the Henon—Heiles Hamiltonian system: a striking and initially unexpected continuation of sequences of eigenvalues from the quasi-periodic to the stochastic regime, the origin of large second differences Δ^2E/sub i/ of eigenvalues arising from variation of a parameter, the comparison of classical and quantal spectra, and a comparison of the "classical" and quantal number of states. In the study of the second differences we find both "crossings" and "avoided crossings" of the eigenvalues. We discuss the importance of overlapping avoided crossings as a basis for a possible theory of "quantum stochasticity".

26481 EXAFS as a probe of local coordination environments of transition metal ions in polycrystalline zeolite catalysts. Co(II) in hydrated zeolite —A and —Y. Morrison, T.I.; Reis, A.H. Jr.; Gebert, E.; Iton, L.E.; Stucky, G.D.; Suib, S.L. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **72**: No. 11, 6276-6282(1 Jun 1980).

Synthetic zeolites exchanged with transition metal or rare earth ions are of immense importance in catalysis, both commercially and in basic research; however, difficulty in growing single crystals and problems of long range disorder make crystallographic studies formidable tasks. In this study, extended x-ray absorption fine structure (EXAFS) spectroscopy has been successfully applied to characterize the local coordination of Co(II) ions in polycrystalline zeolite —A and —Y, thereby establishing the utility of this technique for structural study of intrazeolitic complexes. The Co(II) ions in Co/sub 18.2/Na/sub 20.7/—YxxH_2O are found to be "solutionlike", six-coordinate with Co—O bond distances of 2.06(1) A, but in Co/sub 4.3/Na/sub 3.4/—AxxH_2O and Co/sub 5.5/Na/sub 1.0/—AxxH_2O, they are five coordinate with Co—O distances of 2.07(1) A. The latter result is compatible with several published spectroscopic measurements, but is in conflict with a previous single crystal x-ray diffraction study; this discrepancy has been critically analyzed. The experimental data were collected for ~17 h per sample on an "in house" EXAFS facility employing a standard 1 kW Mo x-ray tube and focussing optics. Hence, EXAFS appears to be a powerful tool for investigating short range order even in materials as complex as zeolites.

BEAMS AND THEIR REACTIONS

26482 (DOE/ER/10444—1) **Infrared absorption spectrum of free carriers in polar semiconductors. Progress report, July 1, 1979-June 30, 1980.** Jensen, B. (Boston Univ., MA (USA)). Feb 1980. Contract AC02-79ER10444. 11p. NTIS, PC A02/MF A01.

The Drude Zener theory of the absorption of high frequency radiation by free carriers (inverse bremsstrahlung) has been extended into the quantum region (h-bar omega > k_0T) in terms of a frequency dependent relaxation time which predicts the dc mobility in the quasiclassical limit. Numerical calculations of the frequency and concentration dependent electron scattering rate have been completed for InP, InAs, $Ga_{0.47}In_{0.53}As$, and previous results for GaAs extended to high carrier concentrations. When starting from a quantum statistical theory, the fact that n/sub q/oh-bar omega → k_0T at low frequencies can be used to prevent the divergence of the coulomb scattering rate without inclusion of a screening radius. A result containing no adjustable parameters is found which predicts a mobility for uncompensated samples that decreases strongly at high concentrations. This has been observed in GaAs, and is not accounted for by the usual dc calculation which assumes h-bar omega = 0 and a screening parameter. Calculated results for GaAs are in good agreement with experimental measurements of the mobility which are found to be independent of a wide variety of conditions of material preparation. This indicates that disagreement with previous theoretical calculations was not due to compensation. Calculations for ZnSe and further investigation of the modification of the optical constants by the presence of an intense laser field and by a static magnetic field are currently planned.

26483 **Multicusp negative ion source.** Ehlers, K.W.; Leung, K.N. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Rev. Sci. Instrum.;* **51**: No. 6, 721-727(Jun 1980).

The characteristics of a steady state, surface conversion, multiline-cusp negative ion source have been investigated for the production of high-energy neutral beams. With the presence of cesium, this source has been operated at a neutral pressure of 1 x 10^{-3} Torr to generate a H^- ion current greater than 400 mA. The percentage of impurities in the self-extracted negative ion beam has been analyzed by a mass spectrometer. A technique for reducing the background electron density at the source exit is also presented.

ATOMIC AND MOLECULAR PROPERTIES

26484 (LA—8249-MS) **P-V-T and sound-velocity data for fluid ^{4}He in the range 75 to 300°K and 2 to 20 kbar.** Liebenberg, D.H.; Mills, R.L.; Bronson, J.C. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 5p. NTIS, PC $5.50/MF $3.50.

Simultaneous measurements were made of static pressure, volume, temperature, and sound velocity in ^{4}He fluid over the range 75 ≦ t ≦ 300 K and 2 ≦ p ≦ 20 kbar (0.2 to 2.0 GPa). The 670 data sets along 14 different isotherms are presented so they are available for developing equations of state. Discussions of the equipment and procedure, accuracy and precision, and equation-of-state development are referenced in this report but are presented elsewhere.

26485 **Photoionization of atomic silver between 17 and 41 eV.** Krause, M.O. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **72**: No. 12, 6474-6478(15 Jun 1980).

Photoelectron spectra of free silver atoms were measured at six energies of the He and Ne discharge lamps. Spectra were obtained at 90 ° and 54.7 ° in relation to the photon beam. The four D term levels were resolved and their branching ratio was found to be nearly statistical and to vary slowly with energy. Spectra indicate the presence of an autoionization resonance near 16.8 eV. The partial photoionization cross section of the 5s level is about 5% of that of the 4d level. The atomic 4d cross section rises slowly above threshold in qualitative agreement with the trend of the atomic potential, and it displays an energy dependence similar to that reported for metallic silver.

26486 **Photodissociative production of O(^{1}S) from N_2O and S(^{1}S) from OCS in rare gas matrices.** Taylor, R.V.; Walker, W.C.; Monahan, K.M.; Rehn, V. (Physics Department, University of California, Santa Barbara, California 93106). *J. Chem. Phys.;* **72**: No. 12, 6743-6748(15 Jun 1980).

Photoluminescence excitation spectra of Ar:N_2O (1%), Ar:OCS (1%), and Kr:OCS (1%) were obtained in the region 180—104 nm, using UV synchrotron radiation at SSRL. Photodissociation energy thresholds in the matrix were found to be: 8.06 eV for $N_2O \rightarrow N_2(X\ ^1\Sigma^+) + O(^1S)$and 7.17 eV for $OCS \rightarrow CO(X\ ^1\Sigma^+) + S(^1S)$. Our results show several effects due to interactions between the matrix and the triatomic molecule: (1) differential blue shifts of the $^1\Pi \leftarrow {}^1\Sigma^+$ and $^1\Sigma^+ \leftarrow {}^1\Sigma^+$ transitions, (2) a greatly enhanced predissociation rate from $^1\Pi$ to $^1\Sigma^+$, (3) matrix dependent energy shifts of a particular Rydberg state, (4) nonradiative energy transfer between the matrix and the triatomic, involving either self-trapped excitons and a Foster—Dexter mechanism or free excitons and a harpooning mechanism. To our knowledge, this is the first observation of the free exciton—harpooning mechanism in a rare gas matrix.

26487 **Vibrational level populations in the autoionization of oxygen.** Eland, J.H.D. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **72**: No. 11, 6015-6019(1 Jun 1980).

Autoionization from the I and I′ resonance series of O_2 has been reexamined using high resolution for photons and electrons. Photoelectron spectra on the resonances are predicted from the upper potential energy surface parameters and photoionization yield curve alone, without reference to the uncertain line shapes and widths. Bond lengths are determined as 1.370 +- .005 A in I and 1.380 +- .005 A in I′ of O_2.

26488 **Strong asymmetric N—H—N hydrogen bond: Neutron diffraction and IR spectroscopic studies of 4-aminopyridine hemiperchlorate.** Roziere, J.; Williams, J.M.; Grech, E.; Malarski, Z.; Sobcyzk, L. (Laboratoire des Acides Mineraux U.S.T.L. 34060 Monpellier Cedex, France). *J. Chem. Phys.;* **72**: No. 11, 6117-6122(1 Jun 1980).

The structure of 4-aminopyridine hemiperchlorate, $C_5H_6N_2x1/2HClO_4$, has been determined from three-dimensional neutron diffraction data. The crystals are monoclinic, space group $P2_1/n$, with cell dimensions a=11.224 (7) A, b=9.325 (6) A, c=16.631 (9) A, β=102.72 (3) ° and Z=4. The structure was refined to an $R(F_0^2)$ =0.102 for 862 reflections with $F_0^2 > \sigma F_0^2$. The structure consists of perchlorate anions and asymmetrically H-bridged $(NH_2PyxHxxPyNH_2)^+$ cations. The cations contain a short, asymmetric, nearly linear $(NxHxxxN)^+$ hydrogen bond (NxxxN=2.698 (8) A, N—H=1.17 (2) A). The dihedral angle between the planes of the N—HxxN bridged pyridine rings is 85°. The IR spectra are consistent with those predicted for this type of bridge system. Strong temperature effects were found to occur both in the stretching frequency region $\nu 2$ and in the low-frequency broad absorption band below 800 cm^{-1}. The ν+band shift towards lower frequencies indicating that the bridge becomes shortened which, in turn, results in an increase of the low-frequency absorption intensity interpreted as a "tunneling" transition.

26489 **Wavelength and vibrational-state dependence of photoelectron angular distributions. Resonance effects in 5 σ photoionization of CO.** Cole, B.E.; Ederer, D.L.; Stockbauer, R.; Codling, K.; Parr, A.C.; West, J.B.; Poliakoff, E.D.; Dehmer, J.L. (Synchrotron Ultraviolet Radiation Facility, National Bureau of Standards, Washington, D.C. 20234). *J. Chem. Phys.;* **72**: No. 11, 6308-6310(1 Jun 1980).

Photoelectron angular distribution were studied for the photoionization of CO for v=0-3 in the range 16—26 eV. (AIP)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

26490 (LA—8151-PR, pp 45-47) **Experimental determination of the relativistic fine-structure-splitting in a pionic atom.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

The aim of the work was to determine the relativistic correction for transitions where the strong-interaction effects are small. Fine-structure splitting of the 5-4 transitions in pionic titanium are tabulated. Corrections due to vacuum polarization, electron screening and strong interaction are included in the theoretical value of 87.6 eV. The measured value was 85.2 +- 3.0 eV. 1 figure, 1 table. (RW)

26491 **Photoelectron spectroscopy of AgCl, AgBr, and AgI vapors.** Berkowitz, J.; Batson, C.H.; Goodman, G.L. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). W-11-10N-ENG-38. *J. Chem. Phys.;* **72**: No. 11, 5829-5837(1 Jun 1980).

He I photoelectron spectra of AgCl, AgBr and AgI vapors have been obtained which differ significantly from earlier work. In each instance, the characteristic features of the diatomic molecule are prominent. The spectral features separate into a valence region, predominantly halogen p-like, and a deeper region, predominantly of Ag 4d character. The latter is split by spin—orbit and ligand field interactions, which are parametrized from the experimental data. Relativistic calculations of the X/sub α/—DVM—SCC type have been performed for these species. At the transition state level, they agree very well with the experimental peak positions. Nonrelativistic calculations of this type have been performed for CuCl and cyclic Cu_3Cl_3. Unlike the AgX species, the CuCl and Cu_3Cl_3 exhibit strong mixing of metal d and halogen p orbitals for the uppermost occupied orbital, and other Cu 3d-like orbitals above the Cl 3p-like orbitals. It is suggested that the occurrence of Cu 3d orbitals in the valence region may play a role in the anomalous diagmagnetic signal and large conductivity changes of CuCl condensed from the vapor.

COLLISION PHENOMENA

26492 (CONF-800626—2) **Absolute photoemission from liquid formamide in the vacuum ultraviolet.** Birkhoff, R.D.; Heller, J.M. Jr.; Painter, L.R.; Hubbell, H.H. Jr. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy; Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 2p. NTIS, PC A02/MF A01.

From 6. international conference on vacuum ultraviolet radiation physics; Charlottesville, VA, USA (2 Jun 1980).

Measurements made with a double ionization chamber reflectance apparatus converted to photoelectron measurement are described. (GHT)

26493 (CONF-800626—3) **Resonantly enhanced multiphoton ionization and third-harmonic generation in krypton and xenon.** Miller, J.C.; Compton, R.N. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01.

From 6. international conference on vacuum ultraviolet radiation physics; Charlottesville, VA, USA (2 Jun 1980).

Multiphoton ionization (MPI) and third-harmonic generation (THG) in gaseous krypton and xenon have been studied using multiple laser photons resonant with numerous atomic energy levels of the target gas. The MPI and THG were studied concurrently in a high-pressure ionization cell with a vacuum ultraviolet (Vuv) radiation detector. Mass-resolved MPI and photoelectron spectra were recorded at low pressure ($< 10^{-4}$ torr) using the time-of-flight (TOF) mass spectrometer and double focusing spherical energy analyzer.

26494 (CONF-800626—4) **Photoionization of atomic copper and silver.** Krause, M.O. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 3p. NTIS, PC A02/MF A01.

From 6. international conference on vacuum ultraviolet radiation physics; Charlottesville, VA, USA (2 Jun 1980).

Cu($3d^{10}4s$) and Ag($4d^{10}5s$) were studied by photoelectron spectrometry using the resonance lines of Helium and Neon discharge lamps. (GHT)

26495 (DOE/ER/04971—2) **Energy-related atomic and molecular structure and scattering studies. Annual progress report, July 1, 1979-June 30, 1980.** Bederson, B. (New York Univ., NY (USA). Dept. of Physics). Mar 1980. Contract ER-78-S-02-4971. 39p. Dep. NTIS, PC A03/MF A01.

The basic goals of this program concern the experimental determination of properties of atoms and simple molecules that are important in a wide range of energy-related processes. In particular we have initiated measurements of polarizabilities of highly polar molecules and dimers, and of a number of atoms distributed through the periodic table, and, of the scattering of low energy electrons by highly polar molecules. For this latter series of measurements an entirely new apparatus has been designed and its external components have been completed. A new electron optics assembly has also been designed and is currently under construction. Details of all these projects are presented; analysis and data of the polarizability measurements are also given.

26496 (DOE/ER/70004—260) **Atomic scale resolution with correlation holography.** Csonka, P.L. (Oregon Univ., Eugene (USA). Dept. of Physics). 1979. Contract EY-76-S-06-2230-004. 7p. NTIS, PC A02/MF A01.

For many atoms (including atoms of interest in biology) the elastic and inelastic photon scattering cross sections (denoted respectively by sigma/sub el/ and sigma/sub inel/) for photons in the wavelength region of interest, satisfy sigma/sub el/ << sigma/sub inel/. Therefore, the probability is high that when illuminated with photons, such an atom will decay before a holographic picture of it can be taken. On the other hand, if certain nonlinear phenomena: correlations between photons are taken into account, a hologram of such atoms can nevertheless be generated. Observation of small objects is compatible with the principles of quantum mechanics, even if the probability of disturbing the object as a result of observation is arbitrarily small.

26497 (ORO—2911-19) **Interaction of heavy ions with matter. Progress report and summary report.** Boring, J.W.; Johnson, R.E. (Virginia Univ., Charlottesville (USA). School of Engineering and Applied Science). Mar 1979. Contract EY-76-S-05-2911. 63p. PC 04/MF A01.

A summary is presented of research performed investigating processes that occur when a heavy atomic particle interacts with matter, with particular emphasis being given to the effects produced on biological systems. Work has been concentrated on ions in the energy range 0-100 keV. (GHT)

26498 (ORO—3027-53) **Excitation and ionization of ions by electron impact. Final report, September 1, 1969-March 31, 1980.** Feeney, R.K.; Hughes, D.W.; Hooper, J.W. (Georgia Inst. of Tech., Atlanta (USA). School of Electrical Engineering). 31 Mar 1980. Contract EY-76-S-05-3027. 23p. NTIS, PC A02/MF A01.

This report presents a brief summary of the technical accomplishments of a research program active from September 1, 1969, through March 31, 1980. All of the work was related to the atomic collision process of importance in magnetic confinement fusion. A chronological tabulation of technical accomplishments, a list of publications, and a summary of progress in the measurement of electron impact ionization cross sections are given.

26499 **Collisional ionization of atomic cesium and potassium by CH_3CN.** Warmack, R.J.; Stockdale, J.A.D.; Schweinler, H.C. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **72**: No. 11, 5930-5934(1 Jun 1980).

Collisional ionization of ground state Cs and K atoms by CH_3CN has been investigated in a crossed-beam experiment for laboratory alkali kinetic energies from 26.5 to 90.7 eV (Cs) and 13.1 to 37.6 eV (K). The kinetic energies and angular distributions of product postive (Cs^+ and K/sup K+/) and negative (CN^-) ions were measured. From these, estimates of the internal energy of the molecular fragments were made. No evidence for production of a stable CN_3CN^- ion through alkali collisions was obtained.

26500 **Analytic estimation of almost resonant molecular energy transfer due to multipolar potentials. VV processes involving CO_2.** Pack, R.T. (Theoretical Division, University of California Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **72**: No. 11, 6140-6152(1 Jun 1980).

A quantum mechanical approach to almost resonant energy transfer by multipolar potentials in molecular collisions is presented. A distorted wave formalism is used, so that most of the limitations of earlier work are retained, but a natural cutoff for the Born approximation is derived which is smooth and physically reasonable. Analytic expressions for the differential and integral cross sections are obtained without a partial wave expansion. Several almost resonant VV energy transfer processes are used as examples, and predictions are given for processes involving $CO_2(00^02)$.

26501 **Crossed beam studies of the hydrogen exchange reaction: The reaction of H and D atoms with T_2 molecules.** Kwei, G.H.; Lo, V.W.S. (Department of Chemistry, State University of New York, Stony Brook, New York, 11794). *J. Chem. Phys.;* **72**: No. 11, 6265-6275(1 Jun 1980).

The dynamics of the hydrogen exchange reaction has been studied in crossed molecular beam experiments using a tritium atom detection scheme. The selectivity and the cumulative feature of T-atom collection provide adequate signal levels and the mass changes introduced by the labeling provide favorable kinematics which allow both a single-valued laboratorybold-arrow-left-rightc.m. transformation and a more efficient laboratory→c.m. conversion of the collision energy. Measured angular distributions of reactively scattered T atoms for the $H+T_2$ and $D+T_2$ systems show that: (1) the product molecules are scattered backwards with respect to the incoming atomic beam implying that these reactions proceed via a direct rebound mechanism, (2) the laboratory angular distributions are quite broad [ranging from ~70 ° to ~125 ° FWHM for D(2120 K)+T_2 and H(2600 K)+T_2, respectively], but agree reasonably well with theoretical predictions if the latter are properly averaged over collision energies; the observed increase in widths of the angular distributions with increasing collision energy appears to be a general property of impulsive collisions involving repulsive barriers, (3) no information is available for the recoil velocity distributions, but the condition E=E′ used in the c.m.→laboratory transformations produce laboratory distributions that provide equally good fits over both branches of the distribution, and (4) under identical conditions, the product T-atom intensity for the $H+T_2$ system is higher than that for the $D+T_2$ system, this difference arises primarily from the different collision energy ranges sampled in the experiments; with a higher temperature H-atom beam, the signal increases substantially, but a quantitative measure of the increase in cross section is precluded by the uncertainty in the H-atom flux. These results are compared with a previous crossed beam study of the $D+H_2$ system and with predictions from various theoretical studies.

26502 **Electron thermalization in gases. II. Neon, argon, krypton, and xenon.** Mozumder, A. (Radiation Laboratory and the Department of Chemistry, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **72**: No. 11, 6289-6298(1 Jun 1980).

Following the theoretical procedure outlined in an earlier paper [J. Chem. Phys. 72, 1657 (1980)], hereinafter referred as I, the present work in an extension to the other rare gases. The following quantities are computed and evaluated: thermalization time and the position distribution at thermalization, time-dependent relaxation rates and evolutions of the directed velocity, width of the positional distribution, and the diffusion coefficient. A Newtonian cooling law has been demonstrated when the effective electron temperature <T> is close to the gas temperature with an equation for the relaxation time of the excess electron temperature. Weighted mo-

ments of the form M/sub n/=<v/sup n/σ/sub m/(v)>/sub T/ have been calculated for n=1 to 10, where σ/sub m/ is the momentum transfer cross section and the symbol <---->/sub T/ denotes averaging with respect to the equilibrium electron velocity distribution at T. The fifth and the seventh moments are related, respectively, to the energy loss rate when <T> is >>T and to the Newtonian cooling rate then <T>≃T. As in I the thermalization parameters are largely independent of initial velocity if the initial electron kinetic energy is much greater than that for the Ramsauer minimum (Ar, Kr, and Xe). Otherwise the thermalization time is considerably reduced. A somewhat analogous situation in neon is attributed to the "incipient" Ramsauer effect. Thermalization time at gas temperature ~300 K increases, according to the present work, in the sequence He, Xe, Kr, Ne, Ar which is contributed jointly by the mass ratio and the behavior of momentum transfer cross section at low energies including the presence or absence of the Ramsauer effect. Comparison with experiments have been made where possible.

26503 Quantum theory of D+H_2 rearrangement collision: Effects of vibrational excitation. Sun, J.C.; Choi, B.H.; Poe, R.T.; Tang, K.T. (Departments of Physics, University of California, Riverside, California 92521). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 18, 1211-1214(5 May 1980).

A quantum mechanical approach is used to calculate the cross sections and rate constants of D+H_2(v/sub α/=1,0) → DH(v/sub β/=0,1)+H. With v/sub α/=0, present results are in agreement with classical calculation. With v/sub α/=1, cross sections for the vibrational adiabatic transition (v/sub α/=1 to v/sub β/=1) is an order of magnitude larger than that for the vibrational nonadiabatic transition (v/sub α/=1 to v/sub β/=0). This result is in agreement with recent experiments but in disagreement with classical-trajectory calculation.

26504 Electron loss from highly excited states of H^0 in collisions with N^{3+}. Kim, H.J.; Meyer, F.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). EY-7045-ENG-26. *Phys. Rev. Lett.;* **44**: No. 16, 1047-1050(21 Apr 1980).

Cross sections for electron loss from excited hydrogen atoms in collision with a N^{3+} beam at 40-keV/amu collision energy were determined using a crossed-beams experiment. The value of the principal quantum number, n, of the excited atoms n investigated ranged from 9 to 24. In this range the electron-loss cross section increases as ~ n^3, in contrast to the n^2 increase predicted by a number of theories.

26505 Energy transfer in ion-polar molecule collisions. Bottcher, C. (Oak Ridge National Lab., TN (USA)). *Chem. Phys. Lett.;* **66**: No. 1, 126-130(15 Sep 1979).

Rotational excitation of HCN in collisions with Na^+ is considered, at energies between 0.1 and 10 eV using a point charge rotating dipole, impact parameter description. The resulting cross sections are interpreted in terms of crossing between Stark-shifted rotational levels. In the region where inelastic collisions dominate, non-polar molecule reactions should proceed through complex formation. The model predicts the same behavior as orbiting models at lower energies, yielding a rate independent of temperature, in agreement with experiment.

GENERAL FLUID DYNAMICS

26506 (K/ET—5011) **Comparison of the effect of non-random surface scattering on free molecule and slip flow.** Fain, D.E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 1980. Contract W-7405-ENG-26. 24p. (CONF-800715—1). NTIS, PC A02/MF A01.

From 12. international symposium on rarefied gas dynamics; Charlottesville, VA, USA (7 Jul 1980).

As a result of this examination of experimental data several tentative conclusions can be drawn. It appears that currently accepted theory cannot calculate the same fraction of diffuse reflection for both slip flow and free molecule flow. Berman's backscattering approximation does not provide any better consistency between the two estimates of diffuse scattering fractions. The author's new result for free molecule flow does appear to provide some better consistency in the calculation of the diffuse fractions. However, in order to get complete consistency, smaller values than are currently accepted for the slip constant and free molecule flow constant are required. The author hopes that these results will provide incentive for further investigation and perhaps additional experimental work. It appears that there is considerably more variation in the diffuse scattering fraction for a given gas with different surfaces than there is for different gases on the same surface. Therefore, the experimental work probably should be directed toward systems with different surfaces and large length to radius ratios. If non-random surface scattering does affect slip and free molecule flow in different ways, then as this examination indicates it can perhaps be used to establish the most accurate theoretical values.

26507 Vortex method for blood flow through heart valves. McCracken, M.F.; Peskin, C.S. (Department of Mathematics, Indiana University, Bloomington, Indiana 47405). EY-76-C-02-3077. *J. Comput. Phys.;* **35**: No. 1, 183-205(Apr 1980).

A combination vortex-grid method for solving the two-dimensional, incompressible Navier—Stokes equations in regions with complicated internal, elastic boundaries is presented. The authors believe the method to be applicable to the case of at least moderately high Reynolds number flow. The method is applied to the study of blood flow through the mammalian mitral valve. Previous work of Peskin is extended and the conjecture that the behavior of mammalian heart valves is independent of Reynolds number is supported.

26508 Particle-fluid numerical model for liquid sprays. Dukowicz, J.K. (Theoretical Division, Group T-3, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG-36. *J. Comput. Phys.;* **35**: No. 1, 229-253(Apr 1980).

A numerical technique has been developed for computing the behavior of atomized non-evaporating liquid sprays injected into a gaseous environment. The same tchnique, however, is applicable to general incompressible flows containing particles or droplets. The method consists of a fully-interacting combination of Eulerian fluid and Lagrangian particle calculations. The interaction calculations are performed simultaneously and non-iteratively. A Lagrangian description of the particles avoids numerical diffusion, and allows individual attributes, such as particle size, composition, etc., to be statistically assigned for each particle. Numerical calculations and comparisons with experimental data are given for some sprays typical of diesel engine fuel injection.

SUPERFLUIDITY

26509 (ANL—80-35) **Scientific Affairs Division of NATO Advanced Study Institute: abstracts for nonequilibrium superconductivity, phonons and Kapitza boundaries.** (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 60p. NTIS, PC A04/MF A01.

Abstracts of papers presented at the meeting are given. Topics covered include: Kapitza resistance; superconducting tunneling; energy gap enhancement in superconductors; instabilities in nonequilibrium superconducting states; exchange of charge between superconducting pairs and quasiparticles; motion of magnetic flux (flux flow); and other new phenomena. (GHT)

26510 (LBL—10923) **Pressurized helium II-cooled magnet test facility.** Warren, R.P.; Lambertson, G.R.; Gilbert, W.S.; Meuser, R.B.; Caspi, S.; Schafer, R.V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 6p. (CONF-800631—1). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

A facility for testing superconducting magnets in a pressurized bath of helium II has been constructed and operated. The cryostat accepts magnets up to 0.32 m diameter and 1.32 m length with current to 3000 A. In initial tests, the volume of helium II surrounding the superconducting magnet was 90 liters. Minimum temperature reached was 1.7 K at which point the pumping system was throttled to maintain steady temperature. Helium II reservoir temperatures were easily controlled as long as the temperature upstream of the JT valve remained above T lambda; at lower temperatures control became difficult. Positive control of the temperature difference between the liquid and cold sink by means of an internal heat source appears necessary to avoid this problem. The epoxy-sealed vessel closures, with which we have had considerable experience with normal helium vacuum, also worked well in the helium II/vacuum environment.

26511 (LBL—10928) **Gravitational convection of subcooled He I and the transition into superfluid He II at atmospheric pressure.** Caspi, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 7p. (CONF-800631—2). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

The propagation velocity of the He II-He I interface at 1 atm was measured in a large experimental cryostat. During cooldown, He II at the lambda temperature propagates up and down in a gravitational field with an interface velocity V/sub b/ which depends on the He I temperature T/sub ∞/. For T/sub ∞/ = 4 K, V/sub b/ = 0.1 mm/sec and for T/sub ∞/ = 2.2 K, V/sub b/ = 2 mm/sec. During warm up, He I propagated with an interface velocity V/sub b/ > 30 mm/sec that was measured as low bound only. A mathematical model gives a temperature dependent interface thickness in the range $2 \times 10^{-3} \approx \delta < 4 \times 10^{-1}$ mm.

OTHER QUANTUM FLUIDS

26512 Elementary diagram calculations for helium. Smith, R.A. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Contract EY-76-S-3001. *Phys. Lett., B;* **85**: No. 2-3, 183-186(13 Aug 1979).

In hypernetted-chain calculations of liquid ^{4}He, elementary diagrams are needed to reconcile the differences between different energy functionals and obtain the correct saturation density and binding energy. Unfortunately, it is only practical to sum small sets of elementary diagrams. In this work, two different ways of grouping elementary diagrams are compared. Diagrams are categorized according to either the number of points or the bond excess, the number of bonds minus the number of points. The two schemes sum plausible and rather different sets of diagrams, yet at any level of truncation considered, the results are similar in the region where the contribution to the energy is large. This agreement provides a numerical check on the convergence of the elementary diagram sum and suggests that results obtained with truncated sums may be quite reliable.

HIGH ENERGY PHYSICS

26513 New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978). 679p. (CONF-780145—).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

Separate abstracts were prepared for twenty-four items from the volume. The volume surveys the most recent advances in high energy physics. (GHT)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

26514 Review of particle properties. Kelly, R.L.; Horne, C.P.; Losty, M.J.; Rittenberg, A.; Shimada, T.; Trippe, T.G.; Wohl, C.G.; Yost, G.P.; Barash-Schmidt, N.; Bricman, C.; Dionisi, C.; Mazzucato, M.; Montanet, L.; Crawford, R.L.; Roos, M.; Armstrong (Technical Associate), B. *Rev. Mod. Phys.;* **52**: No. 2, S1-S286(1 Apr 1980).

This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Phys. Lett. 75B (1978)]. Data are evaluated, listed, averaged, and summarized in tables. Numerous tables, figures, and formulae of interest to particle physicists are also included. A data booklet is available.

ELECTROMAGNETIC INTERACTIONS

26515 (SLAC-PUB—2492) **ξ-scaling.** Gunion, J.F. (California Univ., Davis (USA). Dept. of Physics; Stanford Linear Accelerator Center, CA (USA)). Apr 1980. Contract AC03-76SF00515. 6p. (CONF-800374—2). NTIS, PC A02/MF A01.

From 15. Rencontre de Moriond; Les Arcs, France (9 Mar 1980).

A class of purely kinematical corrections to ξ-scaling is exposed. These corrections are inevitably present in any realistic hadron model with spin and gauge invariance and lead to phenomenologically important M/sub hadron/^{2}/Q^2 corrections to Nachtmann moments.

26516 Observation of three upsilon states. Andrews, D.; Berkelman, K.; Billing, M.; Cabenda, R.; Cassel, D.G.; DeWire, J.W.; Ehrlich, R.; Ferguson, T.; Gentile, T.; Gibbard, B.G.; Gilchriese, M.G.D.; Gittelman, B.; Hartill, D.L.; Herrup, D.; Herzlinger, M.; Kreinick, D.L.; Larson, D.; Mistry, N.B.; Nordberg, E.; Peggs, S.; Pechonok, R.; Plunkett, R.K.; Seeman, J.; Shinsky, K.A.; Siemann, R.H.; Silverman, A.; Stein, P.C.; Stone, S.; Talman, R.; Thonemann, H.G.; Weber, D.; Bebek, C.; Haggerty, J.; Izen, J.M.; Kline, R.; Loomis, W.A.; Pipkin, F.M.; Tanenbaum, W.; Wilson, R.; Sadoff, A.J.; Bridges, D.L.; Chadwick, K.; Ganci, P.; Kagan, H.; Lobkowicz, F.; Metcalf, W.; Olsen, S.L.; Poling, R.; Rosenfeld, C.; Rucinski, G.; Thorndike, E.H.; Warren, G.; Bechis, D.; Chang, G.K.; Imlay, R.; Mueller, J.J.; Potter, D.; Sannes, F.; Skubic, P.; Stone, R.; Brody, A.; Chen, A.; Goldberg, M.; Horwitz, N.; Kandaswamy, J.; Kooy, H.; Lariccia, P.; Moneti, G.C.; Whitman, R.; Alam, M.S.; Csorna, S.E.; Panvini, R.S.; Poucher, J.S. (Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **44**: No. 17, 1108-1111(28 Apr 1980).

Three narrow resonances have been observed in e^+e^- annihilation into hadrons at total energies between 9.4 and 10.4 GeV. Measurements of mass spacings and ratios of lepton pair widths support the interpretation of these "Y" states as the lowest triplet-S levels of the bb-bar quark-antiquark system.

26517 Evidence for planar events in e^+e^- annihilation at high energies. Brandelik, R.; Braunschweig, W.; Gather, K.; Kadansky, V.; Luebelsmeyer, K.; Maettig, P.; Martyn, H.-U.; Peise, G.; Rimkus, J.; Sander, H.G. Contract EY-76-C-02-0881. *Phys. Lett., B;* **86**: No. 2, 243-249(24 Sep 1979).

Hadron jets produced in e^+e^- annihilation between 13 GeV and 31.6 GeV in c.m. at PETRA are analyzed. The transverse momentum of the jets is found to increase strongly with c.m. energy. The broadening of the jets is not uniform in azimuthal angle around the quark direction, but tends to yield planar events with large and growing transverse momenta in the plane and smaller transverse momenta normal to the plane. The simple qanti q collinear jet picture is ruled out. The observation of planar events shows that there are three basic particles in the final state. Indeed, several events with three well-separated jets of hadrons are observed at the highest energies. This occurs naturally when the outgoing quark radiates a hard collinear gluon, i.e., $e^+e^- \rightarrow$qanti qg with the quarks and the gluons fragmenting into hadrons with limited transverse momenta.

26518 Inclusive production of D and K mesons in e^+e^- annihilation. Piccolo, M.; Peruzzi, I.; Rapidis, P.A.; Barbaro-Galtieri, A.; Feller, J.M.; Lueke, D.; Vuillemin, V.; Dorfan, J.M.; Ely, R.; Feldman, G.J. Contract EY-76-C-03-0515;W-7405-ENG-48. *Phys. Lett., B;* **86**: No. 2, 220-224(24 Sep 1979).

The authors present measurements of the cross section for inclusive D and K meson production in e^+e^- annihilation in the center of mass energy range 3.6 to 5.8 GeV. D production accounts for most of the increase in the total cross section for hadron production in e^+e^- annihilation at energies above 4 GeV.

26519 Spin forces in large transverse momentum p-p elastic scattering. Krisch, A.D. (Univ. of Michigan, Ann Arbor). pp 17-56 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The various spin dependent cross sections that can be measured are defined. The hardware required to measure these cross sections is described, and recent results on spin effects at large transverse momentum are shown. The results are related to the short range nucleon-nucleon interaction. (GHT)

26520 Advances in the study of spin effects in nucleon-nucleon scattering at small and intermediate momentum transfers. Neal, H.A. (Univ. of Indiana, Bloomington). pp 57-125 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

New developments in elastic scattering processes are reviewed, including a survey of new developments in p-p and n-p elastic scattering cross sections, polarization, and higher order spin measurements. The existing evidence for a new dibaryon resonance is reviewed and recent data and theoretical analyses of inclusive baryon polarizations are examined. A constituent model of p-p elastic polarization is discussed and examples are given to illustrate the status of the program to determine the scattering amplitudes. (GHT)

26521 What can one learn from very accurate measurements of the lepton magnetic moments. Kinoshita, T. (Cornell Univ., Ithaca, NY). pp 127-143 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The primary purpose of measurements of the anomalous magnetic moments of the electron, positron, and negative and positive muon is to test the validity of the conventional QED, in particular to verify the presence of higher order terms which necessarily involves renormalization of mass and charge. In addition, the inclusion of hadronic effects in a/sub μ/becomes necessary at this level of accuracy. (GHT)

26522 Lepton spin motion in weak magnetic mirror traps. Ford, G.W. (Univ. of Michigan, Ann Arbor). pp 145-157 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

A brief description is given of two averaging methods of nonlinear mechanics used in the precision calculation of the spin and orbital motion of leptons in weak magnetic mirror traps. These methods are: the method of averaging and the method of rapidly rotating phase. The calculations of spin motion are shown and the

application of the results to the last two precision electron g-2 measurements. (GHT)

26523 Electron magnetic moment from geonium spectra. Van Dyck, R.S. Jr.; Schwinberg, P.B.; Dehmelt, H.G. (Univ. of Washington, Seattle). pp 159-181 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

An experiment to determine the electron magnetic moment by measuring in maximum detail the electron orbit in a magnetic field is described. (GHT)

26524 Muon anomalous magnetic moment: the last word. Williams, R.W. (Univ. of Washington, Seattle). pp 183-197 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

A series of g-2 experiments at CERN produced an accuracy of 8 parts per million in the anomaly, or 9 parts per billion in the g-factor; better than was forecast in the proposal and, in fact, challenging the accuracy of the purely GED part of the theoretical calculation and equalling the accuracy of the calculated hadronic correction. The principles of this recent measurement are explained, and it is shown why it is not likely to be repeated soon with much greater precision. (GHT)

26525 Proposed measurements of the anomalous magnetic moment of the electron and positron. Newman, D.; Rich, A.; Sweetman, E. (Univ. of Michigan, Ann Arbor). pp 199-220 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

Two new experiments at the University of Michigan to measure the g-factor anomalies of the electron and positron to accuracies of 25 parts per billion (ppB) and 3 parts per million (ppM) respectively are described. The features of these experiments that differ from previous g-factor measurements and allow higher statistical and systematic accuracy will be emphasized. We will also point out several theories of current interest which will be tested by these results. In particular, we describe in the Appendix how these results will constitute the most precise test of special relativity to date. First, however, we outline recent theoretical and experimental progress in lepton g-factor research.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 26560

26526 Muon scattering at Fermilab. Francis, W.R. (Michigan State Univ., East Lansing (USA). Dept. of Physics); Kirk, T.B.W. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Phys. Rep.;* **54**: No. 5, 307-390(Sep 1979).

A review of the muon scattering program to date at Fermilab is made. Brief sections are included on muon physics at particle accelerators prior to Fermilab and on technical details of the Fermilab muon beam. A section is included on the theoretical work most closely associated with the deeply inelastic muon scattering program.

26527 Neutrino-induced multimuon events from the CDHS experiment. Kleinknecht, K. (Univ., Dortmund, Germany). pp 227-261 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

Experimental results on multimuon production by neutrinos and antineutrinos from the CERN - Dortmund - Heidelberg - Saclay neutrino are presented: (a) 257 (58) fully reconstructed opposite-sign dimuon events (antineutrinos) are interpreted as due to charm production and decay; (b) 28 trimuon ($\mu^-\mu^-\mu^+$) events are compared to different models assuming an electromagnetic, hadronic or purely leptonic origin of the events. The data point towards hadronic μ-pair production as the main source of trimuons; (c) a first tetramuon event $\nu + N \rightarrow \mu^-\mu^+\mu^-\mu^+ X$ has been observed.

STRONG BARYON-INDUCED INTERACTIONS

26528 (LA—8151-PR, pp 51-52) **Angular distribution for pd → ^{3}Heπ^0 at 800 MeV.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Cross sections are plotted as a function of c.m. pion angle and momentum transfer for pd → ^{3}Heπ^0 and pd → ^{3}tπ^+. Slope and normalization for the data are discussed. 1 figure. (RWR)

26529 Hadron-nucleus elastic scattering at 70, 125, and 175 GeV/c. Schiz, A.; Fajardo, L.A.; Majka, R.; Marx, J.N.; Nemethy, P.; Rosselet, L.; Sandweiss, J.; Slaughter, A.J.; Ankenbrandt, C.; Atac, M.; Brown, R.; Ecklund, s.; Gollon, a.J.; Lach, J.; MacLachlan, J.; Roberts, A.; Shen, G. (Yale University, New Haven, Connecticut 06520). *Phys. Rev., D;* **21**: No. 11, 3010-3022(1 Jun 1980).

Hadron-nucleus elastic scattering is measured for π^{+-}, K^{+-}, p, and p-bar scattering from Be, C, Al, Cu, Sn, and Pb targets at incident beam momenta of 70 and 175 GeV/c and for π^+, K^+, and p scattering from Be, Al, and Pb targets at an incident beam momentum of 125 GeV/c. Parametrizations of dσ/dt in the forward direction for the reactions are presented.

26530 Experimental determination of elastic and topological cross sections in 48.9-GeV/c p-barp interactions. Zissa, D.E.; Barnes, V.E.; Carmony, D.D.; Dauwe, L.J.; Gaidos, J.A.; Gutay, L.J.; Laasanen, A.T.; McIlwain, R.L.; Miller, D.H.; Rangan, L.K.; Robertson, R.M.; Willmann, R.B.; Turkot, F. (Department of Physics, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **21**: No. 11, 3059-3063(1 Jun 1980).

The elastic and topological p-barp cross sections have been measured at 48.9 GeV/c in the Fermilab proportional-wire-chamber—30-in.-bubble-chamber hybrid spectrometer. The elastic cross section is 7.81 +- 0.24 mb and the slope of the elastic differential cross section at t=0 is 13.4 +- 0.8 GeV^{-2}. Further, the moments of the inelastic topological-cross-section distribution are <n/sub c/>=5.69 +- 0.03, <n/sub c/>/D=2.10 +- 0.02, and f/sup c/ c_2=1.67 +- 0.12.

26531 Measurement of the p-barp charge-exchange cross section from 0.119 to 1.046 GeV/c. Hamilton, R.P.; Pun, T.P.; Tripp, R.D.; Nicholson, H.; Lazarus, D.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48;ER-78-S-02-4831;EY-76-C-02-0016. *Phys. Rev. Lett.;* **44**: No. 18, 1179-1181(5 May 1980).

Charge-exchange cross section for antiprotons on protons has been measured in closely spaced momentum intervals from 0.119 to 1.046 GeV/c. The regions of the reported resonances at 1936 and 2020 MeV were scanned in 10-MeV/c steps with a typical statistical error of ≃ 1% and an rms mass resolution of +- 1.5 MeV. No enhancements were observed.

26532 Search for the S meson. Hamilton, R.P.; Pun, T.P.; Tripp, R.D.; Lazarus, D.M.; Nicholson, H. (Lawrence Berkeley Laboratory, Berkeley, California 94720). W-7405-ENG48;ER-78-S-02-4831;DE-AC02-76CH00016. *Phys. Rev. Lett.;* **44**: No. 18, 1182-1185(5 May 1980).

Total and annihilation cross sections for p-barp and p-bard have been measured over the momentum range 355—1066 MeV/c at closely spaced momenta and with good energy resolution. No evidence is seen for the narrow structure reported by other experiments in the vicinity of 500 MeV/c. The present measurements indicate a broader enhancement in this region, which, if interpreted as a resonance, would have a height of ~ 3 mb and a width of ~ 20 MeV. This structure appears only in the p-barp data.

26533 Observation of the production of short-lived particles in a high-resolution streamer-chamber experiment. Sandweiss, J.; Cardello, T.; Cooper, P.; Dhawan, S.; Kellogg, R.; Ljung, D.; Ludlam, T.; Majka, R.; McBride, P.; Nemethy, P.; Rosselet, L.; Slaughter, A.J.; Taft, H.D.; Teig, L.; Tzeng, L.; Ecklund, S.; Johnson, M. (Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **44**: No. 17, 1104-1107(28 Apr 1980).

Short-lived particles produced in association with muons have been observed in the interactions of 350-GeV/c protons with neon in a high-resolution streamer chamber. The characteristics of these events are consistent with the expected properties of charmed particles if the average lifetime lies between 10^{-13} and 2 x 10^{-12} sec. With the assumption that the observed events are mainly D^{+-} mesons with lieftimes of approximately 10^{-12} sec, the production cross section is estimated to lie between 20 and 50 μb per nucleon.

26534 Resonant production of high-transverse-momentum back-to-back gluon jets in pp collisions. Aubrecht, G.J. II; Nandi, S.; Wada, W.W. (Ohio State Univ., Columbus (USA). Dept. of Physics). *Phys. Lett., B;* **86**: No. 1, 79-82(10 Sep 1979).

The authors propose the calorimetric study of two-gluon jets arising from inclusive production of 0^{-+}, 0^{++}, and 2^{++} banti b states in hadron-hadron collisions. They predict cross sections of approximately 0.2x10^{-33} cm^2 (approximately 3 x 10^{-33} cm^2) for pp collisions at $\sqrt{s}$=27 GeV (60 GeV). The transverse momentum and angular distributions of the jets are also calculated.

26535 Diffractive production of the charmed baryon Λ^+/sub c/ at the CERN ISR. Giboni, K.L.; Boehm, A. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Experimentalphysik 3B und 3. Physikalisches Inst.); Dibitonto, D.; Hanna, D. (Harvard Univ., Cambridge, MA (USA). Lyman Lab. of Physics); Barone, M.; Ceradini, F. *Phys. Lett., B;* **85**: No. 4, 437-442(27 Aug 1979).

In a sample of diffractive events of high multiplicity a sharp five standard deviation signal is observed at M=2255 MeV/c² in the $K^- p\pi^+$ mass distribution and, although with less statistical strength, at the same mass in the $\Lambda^0\pi^+\pi^+\pi^-$ channel. These signals are identified as being due to the decay of the charmed baryon Λ^+/sub c/ which is produced with a cross section times branching ratio sigma/sub c/B in the range 0.7-1.8 μb for the $K^-\pi^+ p$ decay and 0.3-0.7 μb for the $\Lambda^0\pi^+\pi^+\pi^-$ system.

26536 Limits on the production of neutrino-like particles in proton-nucleus interactions from calorimetry measurements. Dishaw, J.P.; Diamant-Berger, A.M.; Faessler, M.; Liu, J.K.; Merritt, F.S.; Wojcicki, S.G. (Stanford Linear Accelerator Center, CA (USA)); Barish, B.C.; Bartlett, J.F. Contract EY-76-C-03-0515;EY-76-C-03-0068. *Phys. Lett., B;* **85**: No. 1, 142-146(30 Jul 1979).

Using calorimetric techniques, the authors have searched for the production of neutrino-like particles in proton-nucleus collisions. Production limits for different parameterizations of the cross section for these particles are given. Charm production cross section limits imposed by the data are also discussed.

26537 Azimuthal correlation of a high-p/sub T/ π^0 and eta with a second π^0 produced in pp collisions at the ISR. Kourkoumelis, C.; Resvanis, L.K. (Athens Univ. (Greece)); Filippas, T.A.; Fokitis, E. (National Technical University, Athens, (Greece)); Cnops, A.M.; Iwata, S.; Palmer, R.B. *Phys. Lett., B;* **85**: No. 1, 147-150(30 Jul 1979).

The correlation between a high transverse momentum π^0 and eta and a second π^0 have been measured using an apparatus with large azimuth acceptance. The angular distribution of α, measuring the deviation from collinearity in azimuth, peaks near zero. The r.m.s. of the distribution is found to have an inverse logarithmic rather than a 1/p fall-off.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 26265, 26529, 26585, 26603

26538 (LA—8151-PR, pp 56-58) **Accurate measurements of π^{+-} and proton elastic scattering at LAMPF.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Differential cross sections of π^{+-} p elastic scattering were measured at 378 to 625 MeV/c. Results are shown at 408(π^+,π^-), 427(π^-), and 508(π^+) MeV/c and compared with previous measurements. 4 figures. (RWR)

26539 Experimental determination of the structure function of the pion. McCal, D.; LeBritton, J.; Metcalf, W.; Melissinos, A.C.; Alspector, J.; Borenstein, S.; Kalbfleisch, G.; Strand, R.C.; Abashian, A. (Rochester Univ., NY . Contract EY-76-C-02-0016;EY-76-C-02-3065. *Phys. Lett., B;* **85**: No. 4, 432-436(27 Aug 1979).

It was shown previously that dimuon production by 22 GeV pions proceeds in part through qanti q annihilations in agreement with the Drell-Yan model. Using these data, the authors extract the quark distribution function of the pion. Comparison of the structure function with that obtained from data at higher energy reveals differences compatible with the QCD calculations of the Q^2-dependence (scale breaking) of the pion structure function.

26540 Contribution of qanti q annihilations to dimuon production in πN interactions. Reece, C.; LeBritton, J.; McCal, D.; Metcalf, W.; Melissinos, A.C.; Alspector, J.; Borenstein, S.; Kalbfleisch, G.; Strand, R.C.; Abashian, A. . Contract EY-76-C-02-0016;EY-76-C-02-3065. *Phys. Lett., B;* **85**: No. 4, 427-431(27 Aug 1979).

Data on dimuon production by 16 GeV π^+ and π^- beams on a Cu target is presented. From the data the authors evaluate, for π^- N collisions, the fraction of dimuon events that originate from the annihilation process qanti q→$\mu^+\mu^-$. With this information the experimentally determined cross section for the process qanti q→$\mu^+\mu^-$ is observed to be in agreement with the Drell-Yan model over a wide range of incident energies. The observed deviations from exact scaling are of the order predicted by QCD calculations for the Q^2-dependence of the nucleon and the pion structure function.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

26541 (DOE/ER/03069—776) **Invariance, symmetry and periodicity in gauge theories.** Jackiw, R. (California Univ., Santa Barbara (USA). Inst. for Theoretical Physics). Feb 1980. Contract AC02-76ER03069. 67p. (CONF-800238—1). NTIS, PC A04/MF A01.

From 19. internationale universitatswochen fur kernphysik; Schladming, Austria (20 Feb 1980).

The interplay between gauge transformations and coordinate transformations is discussed; the theory will aid in understanding the mixing of space-time and internal degrees of freedom. The subject is presented under the following headings: coordinate transformation laws for arbitrary fields, coordinate transformation laws for gauge fields, properties of symmetric gauge fields, construction of symmetric gauge fields, physical significance of gauge transformations, and magnetic monopole topology without Higgs fields. The paper ends with conclusions and suggestions for further research. (RWR)

26542 Spin from isospin in SU(5). Lykken, J.D.; Strominger, A. (Institute for Theoretical Physics, University of California, Santa Barbara, California 93106). EY-76-C-02-3069. *Phys. Rev. Lett.;* **44**: No. 18, 1175-1178(5 May 1980).

The possibility of the charge-monopole systems with half-integer spin in the grand unified SU(5) model is investigated and found to occur.

26543 Schematic model of quarks and leptons. Harari, H. (Stanford Linear Accelerator Center, CA (USA)). Contract EY-76-C-03-0515. *Phys. Lett., B;* **86**: No. 1, 83-86(10 Sep 1979).

The author considers a scheme in which all quarks and leptons are composites of only two types of fundamental spin-1/2 objects with electric charges 1/3 and 0. The concepts of color and flavor acquire meaning only at the level of the composite systems. Gauge bosons such as W^{+-} or gluons connect only composite states, and are not fundamental. The scheme accounts for several regularities of the observed pattern of quarks and leptons. However, no convincing dynamics are offered, and many important questions are left unanswered.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 26519, 26520, 26558, 26566

26544 Fourth-order quantum-chromodynamic contributions to the e^+-e^- annihilation cross section. Celmaster, W.; Gonsalves, R.J. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **21**: No. 11, 3112-3128(1 Jun 1980).

We compute analytically the logarithmic corrections to the photon propagator to order g^4 in massless quantum chromodynamics. With α/sub c/=$g^2/4\pi^2$ defined by momentum-space subtraction, we find that $\sigma(e^+e^-\rightarrow \text{hadrons})/\sigma(e^+e^-\rightarrow\mu^+\mu^-) = \Sigma$/sub q/ ϵ/sub q/ $^2(1+\alpha$/sub c/$+K\alpha$/sub c/ $^2+xxx)$, where K=463/48+(85/36 √3)$Cl_2(\pi/3)$-11zeta(3)+[(2/3)zeta(3)-23/36]n/sub f/ =-2.193+0.162n/sub f/ for n/sub f/ flavors of quark. The computation is done in momentum space using a novel generalization to 4-ϵ dimensions of the usual Chebyshev-polynomial expansion of Feynman propagators.

26545 Charm photoproduction with linearly polarized photons. Duke, D.W.; Owens, J.F. (Physics Department, Florida State University, Tallahassee, Florida 32306). *Phys. Rev. Lett.;* **44**: No. 18, 1173-1175(5 May 1980).

The photoproduction of charmed particles by polarized photons is calculated in perturbative quantum chromodynamics. For vector gluons the resulting linearly polarized photon asymmetry is found to be large and negative, therefore providing a distinctive test of the proposed production mechanism. Predictions are also given for scalar and pseudoscalar gluons and the magnitude of the cross section is discussed.

26546 Energy correlations in perturbative quantum chromodynamics: a conjecture for all orders. Basham, C.L.; Brown, L.S.; Ellis, S.D.; Love, S.T. (Washington Univ., Seattle (USA)). *Phys. Lett., B;* **85**: No. 2-3, 297-299(13 Aug 1979).

The hadronic energy produced in high-energy electron-positron annihilation has an angular correlation which can be computed by the asymptotically free perturbation theory of quantum chromodynamics. In finite orders, the correlation is not well behaved as the detectors become anti-collinear. The leading behavior has been calculated to fourth order, and an exponential expression for the sum of all orders is discussed. This expression obeys a non-trivial sum rule which lends support for its validity.

26547 Inclusive distribution of photoproduced pions in QCD and the recombination model. Chang, V.; Hwa, R.C. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Contract EY-76-06-2230. *Phys. Lett., B;* **85**: No. 2-3, 285-288(13 Aug 1979).

The joint momentum distribution of a quark and an antiquark in a real photon is calculated in QCD. An argument is given for its usefulness to the photoproduction of pions at low p/sub T/ in the recombination model. With no free parameters except an overall normalization, the inclusive cross section is determined at large x. The result agrees well with experiment.

26548 Do rho, ω, and phi mesons know about QCD perturbation theory. Sanda, A.I. (Rockefeller Univ., New York (USA). Dept. of

Physics). Contract EY-76-C-02-2232B.*000. *Phys. Lett., B;* **85**: No. 2-3, 273-276(13 Aug 1979).

A sum rule is derived which is useful for testing QCD predictions for the reaction $e^+e^- \rightarrow$ hadrons. QCD is found to be in quantitative agreement with the data. The vector mesons do know about QCD perturbation theory.

26549 Estimating inclusive psi and psieta/sub c/ production in e^+e^- annihilation. Kane, G.L. (Stanford Linear Accelerator Center, CA (USA)); Leveille, J.P.; Scott, D.M. (Wisconsin Univ., Madison (USA). Dept. of Physics). Contract EY-76-C-02-0881;COO-881-94. *Phys. Lett., B;* **85**: No. 1, 115-118(30 Jul 1979).

The reaction $e^+e^- \rightarrow$ psi + X provides (i) a test of perturbative QCD, and (ii) a way to study even C states (such as eta/sub c/, chi, Higgs) recoiling against the psi. Estimates of the cross section using QCD, a simple non-perturbative model, and a calculation of the contribution from two-body final states, suggest small but not unmeasurable cross sections. If m/sub eta/sub c// approximately m/sub psi/, this may be a good way to find the ets/sub c/.

26550 Introductory remarks: quark flavors. Meshkov, S. (Californis Inst. of Tech., Pasadena). Contract EY-76-C-03-0068. pp 221-226 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The question of where the next quark flavor n should occur is discussed. It is guessed that it will have a mass of 14 to 15 GeV by extrapolating from lower heavy quark mass ratios. The corresponding anti nn vector meson would have a mass of 30 GeV. The excitation spectrum of quarks is contrasted with that of the hydrogen atom. The possibility of regarding flavor as an excitation of some new degree of freedom in the system is discussed.

26551 Quantum flavordynamics: a status report. Beg, M.A.B. (Rockefeller Univ., New York, NY). Contract EY-76-C-02-2232B. pp 293-312 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The problems posed and the challenges offered by QFD, at this time, are analyzed and discussed. A convenient starting point is afforded by a comparison of the different circumstances of QFD and QCD. Some features of the conventional methodology of QFD, which may be deemed to be questionable, are underlined. The prospects of the standard model are examined in the light of recent experiments, and some theoretical deficiencies of the model are noted. Following a brief comment about the status of some recently proposed models, it is suggested that one search for new physical principles which may be governing the structure of weak interactions in a hitherto unperceived way. Manifest left-right symmetry and time-reversal invariance, realized as symmetries of the Nambu-Goldstone type, are mentioned as possible examples of such principles; additional motiviation for these symmetries emerges in a discussion of recent work on the problem of natural suppression of strong T-violation. The report concludes with a brief appraisal of the present state of QFD.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 26551, 26567, 26577

26552 Dibaryon production in electron-deuteron scattering. Schmidt, I.A. (American University, Washington, D.C. 20016). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 11, 3090-3093(1 Jun 1980).

Estimates are presented for the cross sections for production of dibaryon resonances in electron-deuteron scattering. Two different models, with these resonances as two-body and three-body excited states, are analyzed.

26553 $K \rightarrow \pi e^+ e^-$ in the six-quark model. Gilman, F.J.; Wise, M.B. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 11, 3150-3164(1 Jun 1980).

The decay $K \rightarrow \pi e^+ e^-$ is considered in the six-quark model. The effective Hamiltonian applicable to such decays is calculated in leading-logarithmic approximation and attention is focused on the magnitude of CP-violating effects.

26554 Dimuon measurements and the strange-quark sea. Brock, R. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev. Lett.;* **44**: No. 16, 1027-1030(21 Apr 1980).

This paper discusses a method for the extraction of the ratio f/sub s/$= \int xs(x)dx / \int xd(x)dx$ from dimuon rate measurements in neutrino and antineutrino scattering which takes into account the threshold effects for heavy-quark production. From the y dependence of nu-bar scattering to dimuon final states the parameter m/sub c/ ^{2}, which appears in the definition of the slow rescaling variable $\xi = x + m/\text{sub c/}\ ^2/2EM/\text{sub p/}y$, is estimated. This paper further discusses the crucial uncertainties inherent in the measurement of f/sub s/.

26555 Higher-twist effects in deep-inelastic scattering. Berger, E.L. (Stanford Univ., CA). *Phys. Lett., B;* **89**: No. 2, 241-245(14 Jan 1980).

Nonscaling, nonfactorizing $1/Q^2$ contributions to cross sections are derived for semi-inclusive deep-inelastic scattering, $lN \rightarrow l'\pi X$. These higher twist terms are dominant at large z = p/sub π/ x p/sub N//Q x p/sub N/. They provide unusual (1 - y) terms in the cross section, as well as asymmetries in the azimuthal angle dependence. Calculations are also presented for the quark to pion fragmentation function D/sub π/(z,Q^2). 2 figures.

26556 Determination of quark mass ratios from K/sub l3/ decay. Dominguez, C.A. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **86**: No. 2, 171-174(24 Sep 1979).

Rigorous bounds on K/sub l3/ spectral functions with up to two subtractions are used in order to test the hypothesis m/sub u/ =0. Results strongly support an earlier proof, based on a no-subtraction assumption, which shows that the non-renormalization theorem is badly violated if m/sub u/=0. Also, a relation between the K^{+-}/sub l3/ scalar form factor and the quark mass ratio m/sub u//m/sub s/ is obtained in the soft pion limit. Predictions from this relation are then discussed and compared with other estimates based on the baryon and meson spectra and the eta$\rightarrow 3\pi$ decay.

26557 γ/sub pol/ + N $\rightarrow \pi^{+-}$ + N and the hadron weak current. Lee, H.C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *Phys. Lett., B;* **86**: No. 2, 125-128(24 Sep 1979).

It is pointed out that a very direct way of testing current ideas of the QCD renormalization of the weak neutral interaction between hadrons is to measure the asymmetry in yield induced by left- and right-polarized photons in the reactions γ/sub pol/ + N $\rightarrow \pi^{+-}$ + N. Recent calculations predict the asymmetry to be in the range of 1.5 to 8.0 x 10^{-7}.

26558 Simple formulae for higher-order asymptotic freedom corrections. Bardeen, W.A.; Buras, A.J. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Phys. Lett., B;* **86**: No. 1, 61-66(10 Sep 1979).

The authors present simple formulae for the next-to-the-leading-order asymptotic freedom corrections to the moments of the non-singlet and the singlet combinations of the deep-inelastic structure functions for electron, muon and neutrino scattering.

26559 Cabibbo angle and quark masses in the Weinberg-Salam model. Ma, E.; Pakvasa, S. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Contract EY-76-C-03-0511. *Phys. Lett., B;* **86**: No. 1, 43-46(10 Sep 1979).

The authors examine the renormalization behavior of the Yukawa couplings in the Weinberg-Salam model and discuss its implication for the q^2-dependence of the Cabibbo angle and of the quark masses.

26560 Test for neutrino masses. Kalogeropoulos, T.; Schechter, J.; Valle, J. (Syracuse Univ., NY (USA). Dept. of Physics). Contract EY-76-S-02-3533. *Phys. Lett., B;* **86**: No. 1, 72-74(10 Sep 1979).

If any neutrinos have mass, the reaction $\pi^0 \rightarrow \nu$ anti ν is allowed. With the forthcoming generation of machines this could provide a practical means for finding limits on neutrino masses.

26561 Parity violation and the masslessness of the neutrino. Mannheim, P.D. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Contract AT(45-1)-2230. *Phys. Lett., B;* **85**: No. 2-3, 253-257(13 Aug 1979).

It is proposed that the weak interaction be obtained by gauging the strong interaction chiral flavor group. The neutrinos are then four-component spinors. Higgs fields which transform the same way as pairs of right-handed neutrinos are allowed to acquire a vacuum expectation value. This produces maximal parity violation in both the quark and lepton sectors of the weak interaction, keeps the neutrinos massless, and also leads to the conventional Weinberg mixing pattern.

26562 Constraints on the weak isospin of heavy quarks from non-leptonic transitions. Gavela, M.B. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique Theorique et Hautes Energies); Oliver, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **85**: No. 1, 95-99(30 Jul 1979).

The authors examine non-leptonic transitions which could give straightforward information on the weak isospin of heavy quarks. A sensitive test is provided by the comparison between pure parity-conserving and pure parity-violating decays in certain charge channels, as the F^+ decays phiπ^+ and etaπ^+, or the corresponding D^0 decays $K^{*-}\pi^+$ and $K^-\pi^+$. Both modes are expected to be important within the minimal GIM scheme. A significant (c,s)/sub R/ piece would lead to a strong suppression of one of these modes and to an enhancement of the other one, according to the relative

phase between the left and right parts of the current. The comparison of similar decay modes can give information on the V,A structure of the (t,b) current and even on the (c,d) and (c,b) currents at the Cabibbo-forbidden level.

26563 Like-sign dimuon production by neutrinos and antineutrinos. Smith, J. (European Organization for Nuclear Research, Geneva (Switzerland)); Albright, C.H. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Phys. Lett., B;* **85**: No. 1, 119-123(30 Jul 1979).

The CDHS group has reported evidence for a prompt like-sign dimuon signal in both ν and anti ν beams. A possible explanation for these $\mu^-\mu^-$ and $\mu^+\mu^+$ events is that they arise from the production and decay of a pair of charmed particles. The authors examine a possible canti c model and estimate the magnitude of the cross section for the reaction ν(anti ν) + N $\rightarrow \mu^-(\mu^+)$ + canti c + X. The antineutrino $\mu^+\mu^+$ events are used to set limits on the production and decay of b quarks via the reaction anti ν/sub μ/ + u $\rightarrow \mu^+$ + b, b $\rightarrow$ c + X, c $\rightarrow \mu^+$ + anti ν/sub μ) + s.

26564 Nonleptonic decays of charmed mesons and determination of weak interaction mixing angles. Suzuki, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Contract W-7405-ENG-48. *Phys. Lett., B;* **85**: No. 1, 91-94(30 Jul 1979).

By the U-spin property of SU(3), one important constraint is found on the generalized Cabibbo angles by the decay branching ratios of $D^0 \rightarrow K^-\pi^+$, K^-K^+, and $\pi^-\pi^+$. A substantial deviation of $\Gamma(D^0 \rightarrow K^-K^+)/\Gamma(D^0 \rightarrow \pi^-\pi^+)$ from unity would have a significant implication on the coupling of the charmed quark to heavier quarks of charge -1/3.

26565 New absolutely stable hadrons. Cahn, R.N. (Univ. of Michigan, Ann Arbor). pp 285-292 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The fundamental question which the discovery of the T(9.4) raises is the relationship of the new quark, supposing that this is the proper interpretation of the resonance, to the four previously known quarks. The answer to this may come only when the new e^+e^- machines are completed and conduct detailed studies of the decay patterns of the new pseudoscalars (let us call them D's) which are expected by analogy to the charmed system. Since such experiments are still some time off and since the identification of actual decay modes may well be further off, there is plenty of time for theorists to speculate without fear of being contradicted by real evidence. For nearly all theorists, such speculation means considering some gauge group which, after spontaneous symmetry breaking, yields a unified theory of weak and electromagnetic interactions. After a gauge group is chosen, there is still much freedom in assigning the fermions of the theory to multiplets. These choices are constrained by our knowledge of weak interactions: the standard V-A phenomenology must be reproduced for the charged currents and what is known of the neutral currents must be accounted for as well.

26566 Status of muon-number conservation and comments on parity violation in atoms. Marciano, W.J. (Rockefeller Univ., New York, NY). Contract EY-76-C-02-2232B. pp 313-336 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The present status of muon-number conservation is reviewed, experimental bounds are given and the outlook for the immediate future is described. A detailed description of muon conversion along with a review of theoretical calculations and predictions for this process are presented. Some recent results on parity violation in atoms are reported. (GHT)

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 26559

26567 Composite model of leptons and quarks. Shupe, M.A. (Illinois Univ., Urbana (USA). Dept. of Physics). Contract EY-76-C-02-1195. *Phys. Lett., B;* **86**: No. 1, 87-92(10 Sep 1979).

A heuristic model is presented, treating leptons and quarks as composites of spin-1/2 fields with charges 0, +- e/3. A distinguishability assumption leads to the emergence of three quark colors. The model is extended to consideration of the force-mediating bosons.

26568 Composite hadrons and relativistic nuclei. Blankenbecler, R. (Stanford Linear Accelerator Center, CA (USA)). pp 44-103 of Recent developments in particle and field theory. Dittrich, W. (ed.). Braunschweig, Germany, F.R.; Vieweg (1979).

The author describes a model of hadronic scattering at large momentum transfer. He starts from the hard scattering expansion and discusses some incoherence problems. Then he considers the nonrelativistic limit. Finally he considers as applications of this model the inclusive scattering of nuclei at high energies, the π^- production in the fragmentation region, structure functions and nonscaling in deep inelastic electron scattering from the deuteron, the production of massive lepton pairs, the production of hadrons at large transverse momentum, and the quark-quark scattering.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 26556, 26575

26569 Estimate of flavor number from SU(5) grand unification. Frampton, P.H.; Nandi, S. (Ohio State Univ., Columbus (USA). Dept. of Physics); Scanio, J.J.G. (Cincinnati Univ., OH (USA)). *Phys. Lett., B;* **85**: No. 2-3, 225-228(13 Aug 1979).

The authors analyze the fermion mass matrix generated by a 45 of Higgs in SU(5) and find it equally as good as for the usual 5. One interesting prediction is that the flavor number must be f = 12 to obtain acceptable mass ratios.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 26534

26570 Analysis of the singlet and triplet contributions to the total-cross-section differences $\Delta\sigma$/sub T/ and $\Delta\sigma$/sub L/ in p-p scattering between 1 and 3 GeV/c. Hollas, C.L. (The University of Texas, Austin, Texas 78712). *Phys. Rev. Lett.;* **44**: No. 18, 1186-1189(5 May 1980).

The data from measurements of the total-cross-section differences $\Delta\sigma$/sub T/ and $\Delta\sigma$/sub L/ for p-p scattering and the spin-averaged total cross sections are analyzed to determine the singlet (σ/sub s/ /sup T/) and (σ/sub t/ /sup T/) cross sections. The structures observed in $\Delta\sigma$/sub T/ and $\Delta\sigma$/sub L/ near 1.3 GeV/c are found to result primarily from increases in σ/sub s/ /sup T/ and σ/sub t/ /sup T/. These increases are shown to be consistent with the Mandelstam model of pion production. No resonantlike behavior is required to describe the structures in $\Delta\sigma$/sub T/ and $\Delta\sigma$/sub L/.

26571 Non-leading qanti q and qg contributions in Drell-Yan processes. Humpert, B. (Wisconsin Univ., Madison (USA). Dept. of Physics); van Neerven, W.L. (European Organization for Nuclear Research, Geneva (Switzerland)). Contract EY-76-C-02-0881;COO-881-54. *Phys. Lett., B;* **85**: No. 2-3, 293-296(13 Aug 1979).

The importance of the lowest-order non-log corrections to leading-log asymptotic freedom (AF) is investigated in pp-initiated Drell-Yan μ-pair production. In the present Q^2 ranges the order α/sub s/ qanti q corrections sur-pass DY by a factor 3-5, whereas the analogous qg corrections do not invalidate the AF leading-log approximation.

26572 Viscosity effect in Landau's hydrodynamical model. Hoang, T.F. (Nanyang Univ., Singapore (Malaysia). Dept. of Physics); Phua, K.K. (Argonne National Lab., IL (USA); Nanyang Univ., Singapore (Malaysia). Dept. of Physics). *Z. Phys. C;* **2**: No. 4, 295-299(1979).

The Bose-Einstein distribution is used to investigate Landau's hydrodynamical model with viscosity. In case the viscosity dependence on the temperature is T^3, the correction to the multiplicity behaves like 1/E and is found to be negligible for the pp data. A discussion is presented on a possibility of reconciling $E^{1/3}$ and logE dependence of the multiplicity law.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

26573 Gauge specification in a non-Abelian gauge theory. Jackiw, R. (Rockefeller Univ., New York, NY). pp 589-609 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

Gauge specification in the non-Abelian theory is shown to work differently from Maxwell theory, and the unconstrained temporal gauge is presented which seems especially appropriate for Yang-Mills theory. (GHT)

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

26574 Doubling of weak gauge bosons in an extension of the standard model. Barger, V.; Keung, W.Y.; Ma, E. (Department of Physics, University of Wisconsin-Madison, Madison, Wisconsin 53706). EY-76-C-02-0881;C00-881-126;DE-AC03-76-ER00511. *Phys. Rev. Lett.;* **44**: No. 18, 1169-1172(5 May 1980).

The standard SU(2) x U(1) model is extended to include two W and two Z bosons without changing the structure of its low-energy phenomenology. The experimental implications of this model regarding the existence of a light W and a light Z are discussed.

APPLICATIONS TO STRONG INTERACTIONS

26575 Chiral SU_4 x SU_4 breaking, axial vector current divergences and kaon PCAC. Oakes, R.J.; Sorba, P. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Nuovo Cim., A;* **50**: No. 2, 291-302(21 Mar 1979).

The chiral SU_4 x SU_4 symmetry breaking of the Hamiltonian is investigated by assuming the symmetry-breaking part of the Hamiltonian belongs to a single (4,4-bar)+(4-bar,4) representation of SU_4 x SU_4. The simplest possibilities are classified, each identified with critical orbits in the space of the (4,4-bar)+(4-bar,4) representation, and their relations to quark masses are indicated. The divergences of the axial vector currents are discussed, and their matrix elements are used to obtain relations among masses and coupling constants involving the recently discovered charmed pseudoscalar mesons. Finally, it is pointed out that soft-kaon theorems can be obtained for certain processes involving charged particles by using kaon PCAC due to the relative smallness of the kaon mass. In this case the symmetry breaking is approximately on the critical orbit corresponding to the subgroup SU$_3$ x SU$_3$x U^1/sup d/.

FIELD THEORY

REFER ALSO TO CITATION(S) 26542, 26544, 26545, 26547, 26548, 26553, 26555, 26574

26576 (SLAC-PUB—2491) **Low p/sub T/ fragmentation in QCD.** Gunion, J.F. (California Univ., Davis (USA). Dept. of Physics; Stanford Linear Accelerator Center, CA (USA)). Apr 1980. Contract AC03-76SF00515. 8p. (CONF-800374—1). NTIS, PC A02/MF A01.

From 15. Rencontre de Moriond; Les Arcs, France (9 Mar 1980).

A brief summary of the applications of quantum chromodynamics to low p/sub T/ processes is presented.

26577 Natural relations among neutrino neutral current couplings in gauge theories. Mohapatra, R.N. (City Coll., New York (USA). Dept. of Physics); Sidhu, D.P. (Brookhaven National Lab., Upton, NY (USA)). Contract EY-76-C-02-0016. *Phys. Lett., B;* **85**: No. 4, 389-392(27 Aug 1979).

It is shown that two relations among neutrino neutral current couplings derived by Bernabeu and Jarlskog for SU(2) X U(1) gauge theories remain valid for arbitrary gauge groups of the type G/sub 1L/ X G/sub 2R/, where G/sub 1L) is a group of rank m > = 2 and is either a simple group or a direct product of simple groups provided at least m - 1 diagonal generators satisfy the relations 2T/sub jl//sup u/ + T/sub jL//sup d/ + T/sub jL//sup d = 0 and T/sub u//sub jL/ + 2T/sub jL//sup d/ + T/sub jL//sup ν/ = 0. These conditions are sufficient to make the BJ relation natural, independent of the mechanism of symmetry breaking. Implications of these conditions for theories of flavor dynamics are discussed.

26578 Approximate normalized wave functions for the finite-size Coulomb problem. Friar, J.L. (Los Alamos Scientific Lab., NM (USA). Theoretical Div.). *Z. Phys., A;* **292**: No. 1, 1-6(Aug 1979).

Using perturbation methods developed previously for the finite-size energy shift, the s-state wave functions for a bound lepton in the Coulomb field of a nucleus with an arbitrary charge distribution are developed through order $(Z\alpha)^2$. This technique allows a determination of the finite-size contribution to the normalization of the wave function up to order $(Z\alpha)^2$, both for small separations of the lepton and nucleus and for the lepton outside the nucleus. General features of the wave function are discussed, including the transition of the Dirac problem to the (singular) point charge limit. A practical application is developed using these results.

26579 Supersymmetric theories of particles. Fayet, P. (California Inst. of Tech., Pasadena). Contract EY-76-C-03-0068. pp 413-430 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The construction of spontaneously broken supersymmetric theories of weak, electromagnetic, and strong interactions is shown. A new class of particles is distinguished by means of a new quantum number, R. It includes fermions (new neutrinos such as the Goldstone neutrino, or heavy leptons) as well as bosons (heavy scalars associated with ordinary leptons and quarks). Supersymmetry also relates physical Higgs scalars with massive gauge bosons: they now sit in the same representations of supersymmetry, together with heavy leptons. The production and properties of the new states are discussed. To describe gravitation, we also introduce the graviton and its spin 3/2 partner, the gravitino; the latter becomes massive, while the Goldstone neutrino is eliminated. However, gravitational interactions of the massive gravitino do not vanish in the limit of small coupling constant κ but give back the weak interactions of the Goldstone neutrino.

26580 Spinning string theory from a modern perspective. Schwarz, J.H. (California Inst. of Tech., Pasadena). Contract EY-76-C-03-0068. pp 431-446 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The spinning string theory can be regarded as a locally supersymmetric theory in a superspace with ten Bose and sixteen Fermi dimensions. By making six of the Bose dimensions compact in a space of suitable topology, a four-dimensional theory with $\mathcal{N} = 4$ extended supersymmetry is obtained. The possibility that such a scheme could provide a unified description of all interactions is discussed.

26581 Application of quantum chromodynamics to high transverse momentum hadron production. Fox, G.C. (California Inst. of Tech., Pasadena). pp 517-557 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The application of QCD (Quantum Chromodynamics) to high transverse momentum hadron production is described, and single particle and jet cross-sections and correlation measurements are discussed. The theory is in reasonable accord with the data although uncertainties in the theory and technical ambiguities (mainly caused by the low transverse momentum of most of the data) make incontrovertible conclusions impossible.

26582 Quantized electric flux tubes in QCD. Bars, I. (Yale Univ., New Haven, CT). pp 611-631 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

A formulation of QCD is presented which leads to the string-like quantized electric flux tubes. The approach is based on a new set of quantized variables which satisfy commutation rules which are equivalent to the canonical commutation rules of the ordinary gauge potential and electric field in an axial gauge. (GHT)

26583 Dynamical effects of instantons and merons. Dashen, R. (Inst. for Advanced Study, Princeton, NJ). pp 641-652 of New frontiers in high-energy physics. Perlmutter, A.; Scott, L.F. (eds.). New York, NY; Plenum Press (1978).

From Orbis scientiae conference; Coral Gables, FL, USA (15 Jan 1978).

The dynamical effects of instantons and merons in QCD are reviewed. Instantons act like four dimensional color magnetic dipoles and make the coupling increase very rapidly. At a certain scale they break up into meron pairs and the coupling diverges.

PHYSICS RESEARCH

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 26245, 26631

EXPERIMENTAL TECHNIQUES

REFER ALSO TO CITATION(S) 26604

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 26602

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26600

26584 (LA—8151-PR, pp 41) **Pion-induced deuteron breakup.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

$D(\pi^{++},p\pi^{+-})n$ was studied in a kinematically complete counter experiment at 350 MeV/c. Differential cross sections are plotted vs proton momentum and spectator neutron momentum. Agreement between the data and QFS model was fairly good. 4 figures. (RWR)

26585 (LA—8151-PR, pp 41-43) **Low-energy π^+ p and π^- p elastic scattering.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Preliminary c.m. elastic differential cross sections are shown for π^- + p at 29.1, 49.3, 69.4, and 89.4 MeV. 1 figure. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 26612

26586 **Three-body molecular description of ^{9}Be. I. Born-Oppenheimer approximation.** Fonseca, A.C.; Revai, J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy); Matveenko, A. (Joint Inst. for Nuclear Research, Dubna (USSR)). *Nucl. Phys., A;* **326**: No. 1, 182-192(3 Sep 1979).

A three-cluster model composed of two α-particles and a neutron is used to describe the low-lying spectrum of ^{9}Be. The resulting three-body problem is solved by the Born-Oppenheimer method for different two-body n-α and α-α potentials. Molecular energy curves are obtained that explain the binding mechanisms leading to both the ground state and first excited state of ^{9}Be.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26616

26587 **Exact finite-range distorted-wave Born-approximation analyses of the reactions ^{18}O(p,t)^{16}O, ^{48}Ca(t,p)^{50}Ca, and ^{90}Zr(t,p)^{92}Zr using realistic triton and nuclear wave functions.** Feng, D.H.; Nagarajan, M.A.; Strayer, M.R.; Vallieres, M.; Pinkston, W.T. (Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen O, Denmark). EY-76-C-02-3074. *Phys. Rev. Lett.;* **44**: No. 16, 1037-1040(21 Apr 1980).

Results of exact finite-range distorted-wave Born-approximation calculations are presented for the reactions ^{18}O(p,t)^{16}O, ^{48}Ca(t,p)^{50}Ca, and ^{90}Zr(t,p)^{92}Zr. The calculations employ a realistic triton wave function, and realistic nuclear-structure overlap functions. The theoretical cross sections are in good agreement with experiment which implies that distorted-wave Born approximation provides a satisfactory description of these reactions without recourse to higher-order reaction mechanisms.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 26591

26588 **Observation of isospin mixing in ^{12}C near 19.5 MeV excitation.** Morris, C.L.; Piffaretti, J.; Thiessen, H.A. (Los Alamos Scientific Lab., NM (USA)); Cottingame, W.B.; Braithwaite, W.J.; Joseph, R.J.; Moore, I.B.; Holtkamp, D.B. *Phys. Lett., B;* **86**: No. 1, 31-33(10 Sep 1979).

A strongly isospin-mixed doublet has been found in ^{12}C near 19.5 MeV excitation energy in a comparison of π^- and π^+ inelastic scattering at 162 MeV. The π^+ and π^- comparison technique may be universally employable in self-conjugate nuclei to extract isospin-mixing matrix elements.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26588, 26600

26589 (LA—8151-PR, pp 37-38) **πi and π^- inelastic scattering from ^{16}O at 164 and 230 MeV.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Elastic and inelastic cross sections for π scattering are shown for 164 MeV incident energy. Data were analyzed by distorted-wave impulse approximation. π^-/π^+ cross section ratios are tabulated for each reaction at both energies. 1 figure, 1 table. (RWR)

26590 (LA—8151-PR, pp 38-39) **(π^+,p) reaction on ^{12}C and ^{13}C near 90 and 180 MeV.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Angular distributions for the ^{12}C(π^+,p)^{11}C(g.s.) reaction at 90 and 180 MeV and for the ^{13}(π^+,p)^{12}C(4.43) reaction at 90 and 170 MeV are presented. It is concluded that reaction dynamics play a crucial role in understanding this reaction. 1 figure. (RWR)

26591 **Excitation of unnatural-parity states in ^{12}C by 800-MeV polarized protons.** Moss, J.M.; Glashausser, C.; Baker, F.T.; Boudrie, R.; Cornelius, W.D.; Hintz, N.; Hoffmann, G.W.; Kyle, G.; Love, W.G.; Scott, A.; Thiessen, H.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **44**: No. 18, 1189-1192(5 May 1980).

Cross sections and analyzing powers have been measured for 800-MeV proton inelastic transitions to unnatural-parity states in ^{12}C. Data for the 15.11-MeV 1^+, T=1 state are well explained by a distorted-wave impulse-approximation calculation based on proton-neutron charge-exchange cross sections. Negative analyzing powers were observed for the first time at 800 MeV, for the 12.71-MeV 1^+, T=0 state. Values of A/sub y/ appear to be characteristic of the isospin transfer, and support isospin assignments for states of 18.3 and 19.4 MeV.

26592 **Inelastic pion double charge exchange on ^{16}O at 240 MeV.** Mischke, R.E.; Blomberg, A.; Gram, P.A.M.; Jansen, J.; Zichy, J.; Bolger, J.; Boschitz, E.; Ingram, C.H.Q.; Proebstle, G. (Swiss Institute for Nuclear Research, 5234 Villigen, Switzerland). *Phys. Rev. Lett.;* **44**: No. 18, 1197-1200(5 May 1980).

The deep-inelastic double-charge-exchange reaction ^{16}O(π^+,π^-) has been measured at 50°, 85°, and 130° with 240-MeV incident pions. The doubly differential cross section is peaked at low outgoing pion energies, as is expected from a double-scattering process, and is nearly isotropic. The integrated cross section is 5.8 +- 0.9 mb. The shape of the differential cross section suggests that the low-energy tail in ^{16}O(π^+,π/sup +prime/) scattering at the same energy also arises from double scattering.

26593 **How many nucleons are involved in pion absorption in nuclei?.** McKeown, R.D.; Sanders, S.J.; Schiffer, J.P.; Jackson, H.E.; Paul, M.; Specht, J.R.; Stephenson, E.J.; Redwine, R.P.; Segel, R.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **44**: No. 16, 1033-1036(21 Apr 1980).

The proton yeilds from the interaction of pions on nuclear targets with $12 < \text{or} = A < \text{or} = 181$ were measured in the region of the $\Delta(3,3)$ resonance. The shift in proton energies with angle is analyzed in terms of the average number of nucleons that have participated in absorbing the pion's momentum and total energy. The effective number of interacting nucleons, for both π^+ and π^- incident, is found to be $\sim$ 3 for ^{12}C and increasing to $\sim$ 5.5 for ^{181}Ta. These effective numbers of nucleons are also consistent with the ratio of proton yields from π^+ and π^--induced reactions.

26594 **Composite particle emission in relativistic heavy ion collisions.** Lemaire, M.C.; Nagamiya, S.; Schnetzer, S.; Steiner, H.; Tanihata, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Contract W-7405-ENG-48. *Phys. Lett., B;* **85**: No. 1, 38-42(30 Jul 1979).

Inclusive spectra of d, t and ^{3}He have been measured over a wide range of fragment angles and energies. The observed spectra are well reproduced by the 'coalescence model' with a coalescence radius p_0 which is independent of beam energies and which decreases as the sizes of the target-projectile combinations increase. The sizes of the interaction regions have been derived from these p_0 values. The experimental cross sections generally deviate from predictions of the firestreak model.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 26612

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26587, 26616

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 26597

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26593, 26594, 26601

26595 (LA—8151-PR, pp 53-55) **πi and π^- elastic scattering from ^{40}Ca at 65 MeV.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Angular distributions measured at the Low-Energy Pion Channel are shown. Optical-model parameters used in fitting the data are tabulated. The angular distributions show a considerable amount of structure; this structure indicates that the pion-nucleus interaction is going through a transition in this energy region. 1 figure, 1 tables. (RWR)

26596 (LBL—10555) **Complex fragment emission in relativistic heavy ion collisions.** Lemaire, M.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 28p. (CONF-7910145—1). Dep. NTIS, PC A03/MF A01.

From Colloque Franco-Japonais de Physique Nucleaire avec des Ions Lourds; Saclay, France (8 Oct 1979).

Data relative to proton and pion production produced in central collisions have been reviewed by S. Nagamiya. Therefore, the production of complex fragments is emphasized here. A presentation is made of experimental data on d, t, ^{3}He emission and their discussion in terms of the existing models. The size of fireball derived from the analysis of complex fragments is compared to the results of pion interferometry experiment. Interesting features observed in the distribution of charged particles once an heavy fragment has been detected are reported. Finally, suggestions of phenomena to study with a 4π detector are given.

26597 **Observation of intermediate structure in inelastic proton amplitudes in ^{49}V.** Wells, W.K.; Bilpuch, E.G. (Duke Univ., Durham, NC (USA)); Mitchell, G.E. (North Carolina State Univ., Raleigh (USA)). *Phys. Lett., B;* **86**: No. 1, 18-20(10 Sep 1979).

The magnitudes and relative signs of inelastic proton channel amplitudes were measured for 72 3/2$^-$ resonances in ^{49}V. Localized non-statistical behavior is observed in the inelastic amplitudes.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

26598 **Long-lived positive parity isomer in ^{76}Br.** Kreiner, A.J.; Bermudez, G.G.; Mariscotti, M.A.J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)); Thieberger, P. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Lett., B;* **83**: No. 1, 31-33(23 Apr 1979).

A 4$^+$, 1.3 s isomer has been found at 102.6 keV in ^{76}Br using the ^{75}As(α,3n) reaction. A previously reported band structure is interpreted to decay into this isomer.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26540, 26598, 26602

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

REFER ALSO TO CITATION(S) 26587

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 26607

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 26605

26599 **Low-spin test of the particle rotor model for unique-parity states in ^{109}Pd.** Smith, G.J.; Casten, R.F.; Stelts, M.L. (Brookhaven National Lab., Upton, NY (USA)); Boerner, H.G.; Davidson, W.F.; Schreckenbach, K. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)). Contract EY-76-C-02-0016. *Phys. Lett., B;* **86**: No. 1, 13-17(10 Sep 1979).

A series of experiments has led to the discovery of a set of low-spin, unique-parity states in ^{109}Pd. The particle-rotor model is unable to reproduce the observed level scheme.

NUCLEAR REACTIONS AND SCATTERING

26600 (LA—8151-PR, pp 47-51) **Pion single charge exchange.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

The operation of a π^0 spectrometer of 2.5 MeV resolution and approx 1 msr solid angle is reported. It encompasses a total absorption lead-glass counter and position-sensitive modules of lead glass, three multiwire proportional chambers, and a trigger scintillator. The angular dependence of the π^0 spectra from the ^{3}He(π^-,π^0) reaction at 200 MeV are shown, as are the 7^0 excitation function for the 7Li(π^+,π^0)^{7}Bereaction at 70 to 180 MeV to the isobaric analog state (IAS), and the IAS as seen in the 0^0 spectra from the ^{90}Zr($\pi^+\pi^0$) and ^{208}Pb($\pi^+\pi^0$) reactions at 180 MeV. The relative strength of the isobaric analog excitation at T = 100 MeV is plotted as a function of mass for theta/sub π^0/ = 7^0. 7 figures (RWR)

26601 (LBL—10624) **Search for extreme states in nuclear matter (or looking for collective phenomena).** Gutbrod, H.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 15p. (CONF-800232—2). NTIS, PC A02/MF A01.

From International conference on extreme states in nuclear systems; Dresden, German Democratic Republic (4 Feb 1980).

After some introductory background material, the report discusses data from single-particle inclusive reactions with emission of nucleons and pions. The anomalous neutron-to-proton ratio is explained; pion data show a possible indication of a long-lived fireball. The other major topic is multiparticle correlations (noninclusive data). The energy dissipation in the target nucleus and the process of total disintegration (target explosion) leads over to pressure effects (bounce-off) in the heavy fragment data. The weakness of the fireball/fire streak model is pointed out; the cascade models and the hydrodynamical models are discussed as to their qualitative and quantitative agreement with the data. 35 references, 28 figures. (RWR)

26602 **D-state effects in low-energy (d(pol), t) and (d(pol), ^{3}He) reactions.** Knutson, L.D.; Colby, P.C.; Bieszk, J.A. (Wisconsin Univ., Madison (USA)). *Phys. Lett., B;* **85**: No. 2-3, 209-211(13 Aug 1979).

Measurements of the tensor analyzing powers are presented for (d(pol), t) reactions on ^{91}Zr, ^{119}Sn and ^{208}Pb and for the (d(pol), ^{3}He) reaction on ^{63}Cu. The measurements are sensitive to D-state components in the three-nucleon bound-state wave function and allow one to determine the value of the parameter D_2. The D_2 values are compared with recent theoretical predictions.

26603 **Los Alamos: physics from neutral pion spectrometer.** *CERN Cour.;* **19**: No. 4, 156-157(Jun 1979).

Experiments performed with the neutral pion spectrometer at LAMPF are described. Some results are summarized and a brief description of the spectrometer is given. (W.D.L.).

26604 **Multi-step processes and interference phenomena in quasi-elastic scattering of heavy-ions.** Smilansky, U. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *S.Afr. J. Phys.;* **1**: No. 3-4, 209-221(1978).

From International conference on dynamical properties of heavy-ion reactions; Johannesburg, South Africa (1 - 3 Aug 1978).

Problems connected with the identification of multi-step processes in quasi-elastic scattering, and their application to extract spectroscopic information, are discussed. By means of a few examples from recent studies, the experimental and theoretical situation is analysed and directions for further investigations are suggested.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

REFER ALSO TO CITATION(S) 26618

ENERGY LEVELS AND TRANSITIONS

26605 (ORO—4935-035) **Structure of nuclei far from beta stability. Progress report, May 15, 1979-May 14, 1980.** Zganjar, E.F. (Louisiana State Univ., Baton Rouge (USA). Dept. of Physics and Astronomy). 1980. Contract EY-76-S-05-4935. 21p. NTIS, PC A02/MF A01.

The philosophy behind the experimental approach is described. A list of reports on completed work is given. Comments are offered on work on Au, Tl, and Hg isotopes, neutron-deficient nuclei with 50 $\leqq$ (Z,N) $\leqq$ 82, and neutron-rich nuclei with 28 $\leqq$ Z $\leqq$ 50 and 50 $\leqq$ N $\leqq$ 82. No data are presented, as this work has been reported at length in numerous reports and journal articles. Experimental equipment and procedures and data analysis are summarized briefly. (RWR)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26593

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 26250

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26617

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26600, 26602

26606 (LA—8151-PR, pp 43-45) **Pion double-charge-exchange reactions on ^{209}Bi.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Astatine formation cross sections for 300-MeV π^+ and π^- irradiations of bismuth are given. Evidence for secondary α and ^{3}He reactions was observed. Evaporation-model calculations indicated that the fast α and ^{3}He secondaries were formed through a mechanism other than one invalving a compound nucleus. 2 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

REFER ALSO TO CITATION(S) 26614

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 26263

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26601

SPONTANEOUS AND INDUCED FISSION

26607 (EPRI-NP—999) **Measurements of ^{235}U and ^{239}Pu fission product decay spectra. Final report.** Friesenhahn, S.J.; Lurie, N.A. (IRT Corp., San Diego, CA (USA)). Dec 1979. 151p. NTIS, PC A08/MF A01.

High-resolution gamma-ray and medium-resolution beta fission product spectra were measured at various cooling times after 1000-second irradiations of ^{235}U and ^{239}Pu. The results are compared to calculations based on the Evaluated Nuclear Data Files (ENDF/B), Version IV, fission product data library. 32 figures, 8 tables.

26608 (LA—8151-PR, pp 58-60) **Fast-pion-induced fission of uranium.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Yields of selected isotopes are shown for pion emergies of 100, 190, and 350 MeV, and compared with yields from proton fission at energies approximately 150 MeV higher. 3 figures, 1 tables. (RWR)

26609 **Evidence for nuclear superfluidity in ^{236}U isomeric- and prompt-fission modes.** Fontenla, C.A.; Fontenla, D.P. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **44**: No. 18, 1200-1204(5 May 1980).

Isomer fission in /sup 236m/U, t/sub 1/2/=125 nsec, from ^{235}U(d,pf) was compared with prompt fission ^{235}U(n/sub th/, f), in twin experiments. Fine structure in the total kinetic energy, average total kinetic energy as a function of mass, and mass yield were observed in isomer fission of /sup 236m/U. This observation is compatible with a superfluid descent from saddle to scission points. Two peaks in the total-kinetic-energy distribution from isomer fission are observed near fragment mass 132, and this is interpreted as due to the proton-pairing effect at Z=50.

26610 **Magnitude and alignment of transferred angular momentum in both quasi and deeply inelastic scattering.** Puigh, R.J.; Dyer, P.; Vandenbosch, R. (Washington Univ., Seattle (USA)); Thomas, T.D. (Oregon State Univ., Corvallis (USA)); Nunnelley, L. (Chemeketa Community College, Salem, OR . *Phys. Lett., B;* **86**: No. 1, 24-28(10 Sep 1979).

In-plane and out-of-plane angular correlations of fission fragments in coincidence with projectile-like fragments have been measured for the ^{86}Kr+^{238}U reaction at 730 MeV. The dependence of the magnitude and alignment of the angular momentum transferred to the fissioning heavy reaction product has been determined. Both quantities decrease strongly with decreasing energy loss in the quasi elastic region, in agreement with the predictions of a transport model.

NUCLEAR THEORY

NUCLEAR STRUCTURE

26611 (BNL—27501) **Survey of experimental tests of the IBA model.** Casten, R.F. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 30p. (CONF-800213—9). NTIS, PC A30/MF A01.

From Band structure and nuclear dynamics conference; New Orleans, LA, USA (28 Feb 1980).

A survey of experimental tests of the Interacting Boson Approximation (IBA) Model is presented covering even and odd mass nuclei in the region from A ~ 80 to A ~ 230. Both positive and negative parity states with both high and low spin are discussed. Topics included concern energy levels, electromagnetic transition rates, two nucleon transfer and inelastic scattering. Special attention is given to nuclear symmetries and transitional regions. Comparison with other models is made where appropriate. The distinction between IBA-1 and IBA-2 is discussed including their respective areas of applicability.

26612 **Calculation of giant resonances with time-dependent Hartree-Fock.** Blocki, J. (Institute of Nuclear Research, Warsaw (Poland)); Flocard, H. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). *Phys. Lett., B;* **85**: No. 2-3, 163-166(13 Aug 1979).

The time-dependent Hartree-Fock method with the Skyrme interaction has been used to calculate energies of the monopole and quadrupole isoscalar and isovector resonances for several nuclei throughout the periodic table.

NUCLEAR MATTER

REFER ALSO TO CITATION(S) 26619

26613 **Sum rules for Landau parameters in nuclear matter.** Friman, B.L. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)); Dhar, A.K. (Niels Bohr Inst., Copenhagen (Denmark)). Contract EY-76-S-02-3001. *Phys. Lett., B;* **85**: No. 1, 1-4(30 Jul 1979).

The Pauli principle sum rules for the Landau parameters in nuclear matter are derived, including the effects of tensor forces.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 26621

26614 (LA-UR—80-1280) **Effect of the nuclear equation of state on high-energy heavy-ion collisions.** Nix, J.R.; Sierk, A.J.; Strottman, D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 25p. (CONF-800709—1). Dep. NTIS, PC A02/MF A01.

From Seminar on high-energy nuclear interactions and properties of dense nuclear matter; Hakone, Japan (7 Jul 1980).

The effect of the nuclear equation of state on high-energy heavy-ion collisions is studied in two separate ways on the basis of conventional nuclear fluid dynamics. The equation of state has the property that the speed of sound approaches the speed of light in the limit of infinite compression. In the first way, nonrelativistic equations of motion are solved for various values of the nuclear compressibility coefficient for the expansion of spherically symmetric nuclear matter. The matter is initially compressed and excited in head-on collisions of equal targets and projectiles at a laboratory bombarding energy of 250 MeV/A. When the matter expands to a freezeout density, the remaining thermal energy is superimposed in terms of a Maxwell-Boltzmann distribution. The resulting energy distributions for different values of the compressibility coefficient are similar to one another, but they are significantly different from a Maxwell-Boltzmann distribution corresponding to entirely thermal energy and moderately different from the energy distribution corresponding to the Siemens-Rasmussen approximation. In the second way, relativistic equations of motion are solved numerically in three spatial dimensions for the reaction ^{20}Ne + ^{238}U at a laboratory bombarding energy per nucleon of 393 MeV/A, both with and without a density isomer. The double-differential cross section $d^3\sigma/dE d\Omega$ corresponding both to all impact parameters and to central collisions constitut-

ing 15% of the total cross section is computed. The results for the various equations of state are very similar to one another except for central collisions at laboratory angle $\theta = 30^0$ and for both central collisions and all impact parameters at $\theta = 150^0$. In these cases, over certain ranges of energy, $d^2\sigma/dEd\Omega$ is larger for the density isomer than for conventional equations of state. 8 figures.

26615 Volume emission of pions in relativistic heavy ion collisions. Garpman, S.I.A.; Sperber, D. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Glendenning, N.K.; Karant, Y. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **86**: No. 2, 133-136(24 Sep 1979).

The authors consider the possibility of volume emission of pions by the Δ(1232) decay in a hot compressed projectile-target residue. The momentum distribution of the pions created by the two-body Δ(1232) decay is calculated. Reabsorption is taken into account in a quasi-deuteron model. It is argued that low-energy pions created deep inside the hot zone are likely to escape and contribute to the pion inclusive spectrum.

26616 Polarization in elastic proton-nucleus scattering. Osland, P.; Glauber, R.J. (Harvard Univ., Cambridge, MA (USA). Lyman Lab. of Physics). Contract EY-76-C-02-3064. *Nucl. Phys., A;* **326**: No. 2-3, 255-288(10 Sep 1979).

The polarizations which result from the elastic scattering of protons by spin-zero nuclei are discussed by means of the multiple-diffraction approximation. They are found to depend largely on the elementary proton-nucleon central-force and spin-orbit scattering amplitudes and, at least for heavy nuclei, to depend very little upon the remaining proton-nucleon amplitudes which are proportional to the spins of the target nucleons. In particular, the values of the polarization measured at small angles can be used to determine the imaginary part of the forward proton-nucleon spin-orbit scattering amplitude. The real part of that amplitude, on the other hand, is much less sensitively determined by the polarization distributions. Its evaluation will probably require more detailed measurements on the proton spin distribution. It is shown that the effects of the Coulomb field on the polarization distributions are significant at all scattering angles. Included among these electromagnetic effects is the relativistic interaction of the proton magnetic moment with the Coulomb field.

26617 Theoretical investigation of shell effects in deep inelastic collisions. Sobotka, L.G.; Mathews, G.J.; Moretto, L.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Z. Phys., A;* **292**: No. 2, 191-195(Sep 1979).

The relative importance of three different influences of independent-particle shell structure on the nucleon transport process during heavy-ion collisions are discussed. Results of calculations for the 620-MeV $^{86}Kr + {}^{197}Au$ system are presented.

26618 Surface structure of deformed nuclei by radial and angular localization in heavy ion scattering. Neese, R.E.; Guidry, M.W. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy); Donangelo, R.; Rasmussen, J.O. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **85**: No. 2-3, 201-205(13 Aug 1979).

A new method is introduced for determining heavy-ion potentials which exploits semiclassical radial and angular localization at the nuclear surface. The procedure is used to generate a nuclear potential energy surface for the scattering of heavy ions from a deformed nucleus.

26619 High temperature matter and heavy ion collisions. Kapusta, J.I. Berkeley, CA; Univ. of California (1978). 144p. University Microfilms Order No. 79-14,655.

Thesis (Ph. D.).

The possibility that collisions between heavy ions at relativistic energies lead to the formation of high-temperature matter is considered. The formalism necessary to accommodate particle production in a nuclear fireball model when there are conserved quantum numbers is developed. This formalism assumes that, as the fireball expands from some initial high density, it will reach some critical hadron number density, of the order of typical nuclear densities, beyond which all further hadron-hadron interactions are negligible. Noninteracting gas formulas for both stable particles and resonances are applied at this critical density to obtain single-particle momentum distributions. The sensitivity of the pion and nucleon spectra on the value of this critical density is investigated. Detailed comparisons with data then carried out by the use of diffuse nuclear matter distributions for the colliding nuclei. Overall good agreement is found for the single-particle spectra of protons, deuterons, tritons, ^3He, and ^4He. At beam energies below 1 GeV/nucleon however, the number of pions was overestimated, especially at high transverse momentum. The density at which hadrons effectively cease to interact, which is the only parameter in the model, is determined to be 0.12 +- 0.02 hadrons/fm^3. To investigate the properties of very-high-temperature matter the thermodynamic potential of quantum chromodynamics is calculated perturbatively. Due to asymptotic freedom the interactions of die out and the equation of state of a free gas is approached at high temperature. At low temperatures the series diverges. The Hagedorn temperature may not be a limiting temperature at all, but rather the temperature of a phase transition from hadron matter to quark-gluon matter.

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 26599

26620 (UCID—18645) Three lectures on effective interaction in nuclei. Moszkowski, S.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 41p. NTIS, PC A03/MF A01.

The first lecture discusses the origins of the density dependence of the effective interaction. The significance of effective interactions in nuclei is noted. The lowest-order treatment of the short-range repulsion in the nucleon-nucleon interaction (the separation method) and an improved treatment including some of the effect of the nuclear medium on the interaction (dispersion effect) are reviewed. Density dependence and effective three-body interactions and also isospin asymmetry effects are discussed as well. The second lecture examines surface peaking of the effective interaction and why the shell model works. Average interaction energy between valence nucleons and pairing are considered. In concluding this lecture the author explains why the nuclear shell model works and how it could break down if the interaction were not density dependent. The final lecture presents essential features of the effective interaction for nuclear structure calculations. The surface-delta interaction is discussed, brief remarks are made concerning the effective interaction at high energies, and a summary of the dozen most important points of the lectures is given. 1 figure. (RWR)

26621 Fragmentation of the projectile in relativistic heavy-ion collisions. Malfliet, R.A.; Karant, Y. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **86**: No. 3-4, 251-255(8 Oct 1979).

The fragmentation of the projectile in relativistic heavy-ion reactions is usually described in terms of a two-step model called abrasion-ablation. The abrasion part is reformulated in the framework of the Boltzmann equation. The results are compared with other approaches and with experiment.

26622 Spin-orbit potential for t and ^3He elastic scattering. Thompson, W.J. (North Carolina Univ., Chapel Hill (USA)). *Phys. Lett., B;* **85**: No. 2-3, 180-182(13 Aug 1979).

Comparison of integrals of optical-model spin-orbit and real central potentials for t and ^3He scattering with those for nucleon and deuteron scattering demonstrates that t and ^3He spin-orbit strengths are anomalously large when compared with conventional folding-model potentials.

26623 Generalization of quasispin to monopole and quadrupole pairing. Ginocchio, J.N. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **85**: No. 1, 9-13(30 Jul 1979).

A generalization of the quasispin group for monopole pairing to a group which includes both monopole and quadrupole pairing is discussed. Shell model hamiltonians with monopole and quadrupole pairing are shown to have a rich variety of eigenspectra.

26624 Droplet model. Myers, W.D. pp 233-257 of Clustering and fission. Berkeley, CA; University of California (1979).

The effectiveness of the liquid drop model is noted, and this model and the leptodermous (A/sup -1/3/ << 1) approaches in general are related to other methods in many-body theory. Then the Hill-Wheeler box is used to show that the leptodermous approach is applicable to quantum systems with even relatively small numbers of particles. The smooth part of the total energy is separated from the shell effects; it is clear that an A/sup 1/3/ term must be included. After a brief introduction to the methods used to obtain the droplet model energy equation, a simplified version is used to display the most important new terms that enter. The theory is applied to calculation of nuclear ground-state masses and single-particle potential well parameters. 17 figures. (RWR)

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 26497

26625 (CONF-790889—3) Wake fluctuations. Ritchie, R.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From Workshop on physics with fast molecular-ion beams Argonne, IL, USA (20 Aug 1979).

Under many conditions of importance in experiment, fluctuations in the wake of a leading ion in condensed matter are relatively unimportant compared to fluctuations accompanying direct interaction with the medium. The reason is that the wake of a leading ion is composed in the main of relatively small perturbations of large numbers of electrons. These perturbations may add to yield a large average force but, because they carry small momenta, give rise to rather small fluctuations of the force about its mean value. (GHT)

26626 (CONF-800626—5) **Electron mean free paths in solid organic insulators.** Williams, M.W.; Ashley, J.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01.

From 6. international conference on vacuum ultraviolet radiation physics; Charlottesville, VA, USA (2 Jun 1980).

An empirical relation is formulated from which the mean free path of an electron in any solid organic insulator can be calculated over the range of electron energies from 100 eV to 10 keV. (GHT)

26627 **Elementary solutions of the linear transport equation for continuously varying spatial media.** Pomraning, G.C.; Larsen, E.W. (School of Engineering and Applied Science, University of California, Los Angeles, California 90024). *J. Math. Phys. (N.Y.);* **21**: No. 7, 1603-1612(Jul 1980).

We demonstrate that it is possible to construct elementary solutions (eigenfunctions) of the linear transport equation for certain types of continuously varying spatial media. In general, both discrete and continuum modes result, which appear to be complete on the half-range. A detailed analysis is given for an "exponential" medium, including numerical results and a half-range completeness proof. A "linear" medium is also considered. A general method is presented for constructing, jointly, the spatial variation of a medium and the corresponding functional forms of the eigenfunctions. Our results represent a partial generalization of the singular eigenfunction technique to media with continuous spatial variation.

SHIELDING CALCULATIONS AND EXPERIMENTS

26628 (ORNL/RSIC—5/V6) **Bibliography, subject index, and author index of the literature examined by the radiation shielding information center. Volume 6. Reactor and weapons radiation shielding.** (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 368p. NTIS, PC A16/MF A01.

An indexed bibliography is presented of literature selected by the Radiation Shielding Information Center since the previous volume was published in 1978 in the area of radiation transport and shielding against radiation from nuclear reactors, x-ray machines, radioisotopes, nuclear weapons (including fallout), and low energy accelerators (e.g., neutron generators). The bibliography was typeset from data processed by computer from magnetic tape files. In addition to lists of literature titles by subject categories (accessions 4951-6200), an author index is given.

NEUTRON INTERACTIONS WITH MATTER

26629 (CONF-791058—73) **Neutron total cross section of ^{233}U from 0.01 to 1.0 eV.** Harvey, J.A.; Moore, C.L.; Hill, N.W. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 2p. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The neutron total cross section of ^{233}U from 0.01 to 1.0 eV was measured at ORELA using a repetition rate of 25 sec^{-1} and a 17.872-meter flight path. Two samples of ^{233}U enriched to 99.76% with inverse thicknesses of 165.2 and 321.1 barns/atom were measured. The data were corrected for neutron and gamma ray backgrounds which were $\leq$ 1%. Results from the two samples are in good agreement. The data are compared to earlier data and to ENDF/B-V evaluation.

26630 (CONF-800607—47) **Simple monotonic interpolation scheme.** Greene, N.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

A procedure for presenting tabular data, such as are contained in the ENDF/B files, that is simpler, more general, and potentially much more compact than the present schemes used with ENDF/B is presented. The method has been successfully used for Bondarenko interpolation in a module of the AMPX system. 1 figure, 1 table. (RWR)

26631 (CONF-800607—49) **Significance of Lagrange multipliers in cross-section adjustment.** Wagschal, J.J.; Yeivin, Y. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

A natural derivation of the explicit prescriptions incorporated in least-squares adjustment codes is given. The central role of the Lagrange multpliers in this conditional-minimum problem is noted. The evaluation of the Lagrange multipliers necessitates the inversion only of a small matrix, the order of which is the number of integral data by which the cross sections are adjusted. The complete solution of (the adjustment problem, i.e., the adjusted differential and integral parameters and their respective uncertainty (variance-covariance) matrices, is given in terms of the Lagrange multipliers by simple expressions involving no additional matrix inversions. (RWR)

26632 (CONF-800607—50) **Escape and transmission probabilities in cylindrical geometry.** Bjerke, M.A. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

An improved technique for the generation of escape and transmission probabilities in cylindrical geometry was applied to the existing resonance cross section processing code ROLAIDS. The algorithm of Hwang and Toppel, [ANL-FRA-TM-118] (with modifications) was employed. The probabilities generated were found to be as accurate as those given by the method previously applied in ROLAIDS, while requiring much less computer core storage and CPU time. (RWR)

26633 (ORNL/TM—7038) **FCXSEC: multigroup cross-section libraries for nuclear fuel cycle shielding calculations.** Ford, W.E. III; Webster, C.C.; Diggs, B.R.; Pevey, R.E.; Croff, A.G. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 48p. (ENDF—287). NTIS, PC A04/MF A01.

Starting with the pseudo-composition-independent VITAMIN-C cross-sectin library, composition-dependent fine-(171n-36γ) and broad-group (22n-21γ) self-shielded AMPX master, broad-group microscopic ANISN-formatted, and broad-group macroscopic ANISN-formatted cross-section libraries were generated to be used for nuclear fuel cycle shielding calculations. The specifications for the data and the procedure used to prepare the libraries are described.

MEDICAL PHYSICS

RADIATION SOURCE CALIBRATION AND STANDARDIZATION

REFER ALSO TO CITATION(S) 26263

DOSIMETRY

REFER ALSO TO CITATION(S) 26403

26634 (LA—8151-PR, pp 67-68) **Pion beam microdosimetry.** Nov 1979.

In Medium-energy physics program. Quarterly progress report, November 1-January 31, 1979.

Differential and integral dose are plotted per logarithmic internal of lineal energy for various positions along the depth-dose curve. Contributions of various particles to the dose are discussed. 3 figures. (RWR)

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 26482

26635 (LBL—10554) **Coherent Raman spectroscopy via surface plasmons.** Shen, Y.R.; Chen, C.K.; de Castro, A.R.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 5p. (CONF-800808—1). NTIS, PC A02/MF A01.

From 7. international conference on raman spectroscopy; Ottawa, Canada (4 Aug 1980).

Portions of document are illegible.

Coherent antiStokes Raman scattering resulting from mixing of surface plasmons in investigated. The technique is shown to be sensitive and surface-specific.

26636 **Debye-Waller factors for incommensurate structures.** Axe, J.D. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4181-4190(15 May 1980).

Overhauser has predicted that thermal fluctuations in the phase of the modulation wave will give rise to large Q-independent Debye-Waller factors for incommensurate diffraction satellites. We show that a key to understanding this surprising result is a spatial modulation of the fluctuation of atomic positions in an incommensurate solid. The range of validity of Overhauser's assumptions is

discussed and an alternate calculation which should be valid over a larger range of relative fluctuation amplitude is presented. This new calculation predicts the existence of fluctuation- and displacement-dominated regimes, in which higher-order diffraction satellites display qualitatively different behavior.

26637 Self-consistent cluster theory for systems with off-diagonal disorder. Kaplan, T.; Leath, P.L.; Gray, L.J.; Diehl, H.W. (Solid State Division, Oak Rdige National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4230-4246(15 May 1980).

A self-consistent cluster theory for elementary excitations in systems with diagonal, off-diagonal, and environmental disorder is presented. The theory is developed in augmented space where the configurational average over the disorder is replaced by a ground-state matrix element in a translationally invariant system. The analyticity of the resulting approximate Green's function is proved. Numerical results for the self-consistent single-site and pair approximations are presented for the vibrational and electronic properties of disordered linear chains with diagonal, off-diagonal, and environmental disorder.

26638 Site blocking and correlated defect motion in tracer and chemical diffusion. McKee, R.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4269-4281(15 May 1980).

A method is developed for analyzing defect-diffusion coefficients. Defect diffusion is an integral part of considerations in diffusion theory for atom motion in crystals, but it has not been developed as a distinct concern in diffusion kinetics. An "alloy" of tracer and nontracer atoms occupying octahedral interstices of the fcc lattice has been used as a model to develop quantitative descriptions of site blocking, correlation, and flow effects that are all characteristic elements of defect-diffusion kinetics. Correlated walk of vacancies in and near a divacancy can be discussed using these results, and this analysis suggests a method for generalizing theoretical treatments of atom-defect and defect-defect interactions in diffusion-related phenomena.

26639 Solutions to the Boltzmann equation for electrons in a metal: Energy dependence. Pinski, F.J. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **21**: No. 10, 4380-4388(15 May 1980).

The solution to the Boltzmann equation for electrons in a metal is a distribution function which depends on energy and wave vector. This paper solves for the energy dependence by expanding the distribution function in sets of orthogonal functions, (a) energy polynomials, (b) Legendre polynomials in tanh(ϵ/sub k//2k/sub B/T), or (c) a combination of these two choices. To study only the effects of the energy dependence, the electrical and thermal conductivities were calculated for a class of isotropic models. For one of these models, the electrical resistivity is 37% lower than the Bloch-Grueneisen result at a temperature of 0.15 (in units of the Debye temperature, Θ/sub D/). For thermal resistivity, this method is consistent with the result of Klemens; i.e., at very low temperature the correction to the lowest-order result is 51%. Corrections are important at temperatures as high as 0.3 Θ/sub D/. These results show that the standard, i.e., simple variational, results for the temperature dependence of transport coefficients make significant errors. However, by the methods of this paper, accurate results can be obtained quite easily by computer, not only for simple isotropic models, but also for realistic metals. Results for transition metals are briefly mentioned; more complete calculations will be presented elsewhere.

26640 Self-diffusion via sine-Gordon solitons. Gunther, L.; Imry, Y. (Physics Department, Tufts University, Medford, Massachusetts 02155). *Phys. Rev. Lett.;* **44**: No. 18, 1225-1229(5 May 1980).

Theoretical evidence is presented that for temperatures so low that k/sub B/T is much less than the rest energy of a soliton, the mean square displacement of a diffusing particle of an infinite sine-Gordon chain behaves as t/sup 1/2/ for times much longer than microscopic times but much shorter than the soliton lifetime tau. For times much greater than tau, linear behavior is suggested. Finite-size effects are discussed in the context of recent computer simulation studies.

26641 Modified Patterson superposition technique using multiple vectors. Jacobson, R.A.; Beckman, D.E. (Iowa State Univ., Ames). *Acta Crystallogr., Sect. A;* **35**: 339-340(1979).

A modified Patterson superposition procedure is presented in which multiple vectors instead of single vectors are utilized. It is demonstrated that by using certain guidelines a map that results from a superposition using a multiple vector can be shifted and superimposed on itself to yield an image of the structure containing many fewer extraneous peaks.

SUPERCONDUCTIVITY

REFER ALSO TO CITATION(S) 26127, 26509

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 26118, 26131

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

26642 Semiclassical results on normalization of bound state wavefunctions. Moxhay, P.; Rosner, J.L. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). EY-76-C-02-1764. *J. Math. Phys. (N.Y.);* **21**: No. 7, 1688-1694(Jul 1980).

Some methods are introduced and tested for approximating s-wave Schroedinger wavefunctions at the origin, and for examining their dependence on reduced mass of the bound system. Methods are discussed both for nonsingular and singular potentials. The approximations, previously tested for power-law potentials, are found to be exact for the Hulthen potential and excellent for a wide range of parameters in Coulomb+linear potentials: V(r)=-A/r+Br. General theorems for mass dependences are reviewed and extended; these theorems apply to potentials with a definite sign of d^2V/dr^2. Some specific instances in which d^2V/dr^2 does not have a unique sign and the theorems do not hold are also discussed.

26643 Gel'fand—Levitan equation can give simple examples of non-self-adjoint operators with complete eigenfunctions and spectral representations. I. Ghosts and resonances. DeFacio, B.; Moses, H.E. (Ames Laboratory-USDOE and Department of Mathematics, Iowa State University, Ames, Iowa 50011). *J. Math. Phys. (N.Y.);* **21**: No. 7, 1716-1723(Jul 1980).

It is shown that the Gel'fand—Levitan equation for the radial and one-dimensional Schroedinger equations yield complex and singular potentials which support complete sets of eigenfunctions. Explicit examples are given involving complex point eigenvalues and/or complex or negative normalization for the corresponding eigenfunctions. Ghosts and other resonance phenomena thus appear as special cases of this more general inverse spectral theory. It is hoped that these explicit examples for simple situations will clarify ideas relating to non-self-adjoint operators occurring in field theory, scattering theory, and the use of inverse spectral transforms to solve certain classes of nonlinear equations. The treatment given here indicates that the Gel'fand—Levitan equation is a powerful tool in constructing operators with spectral decompositions, even when the operator is not self-adjoint.

STATISTICAL PHYSICS AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 26484, 26645

26644 "Critical clusters" in a supersaturated vapor: Theory and Monte Carlo simulation. Binder, K.; Kalos, M.H. (IFF, KFA Juelich, Juelich, West Germany). EY-76-C-02-3077000. *J. Stat. Phys.;* **22**: No. 3, 363-396(Mar 1980).

A new thermodynamic analysis is given for the equilibrium between a liquid cluster and the surrounding supersaturated gas phase in a finite constant volume. It is shown that for constant total density and intermediate volume this equilibrium is stable, although it is unstable for very large volume. We show that observation of the critical cluster size l* then yields information on the surface free energy of the liquid cluster. THe accuracy of previous approximate prescriptions for obtaining the free energy of physical cluster is investigated. As an application, the theory is used to analyze Monte Carlo simulations of the two-dimensional lattice gas model at low temperatures. We obtain cluster surface area, diffusivity, and free energy for clusters with 26 < or =l< or =500. It is found that the capillarity approximation is inaccurate for l< or =100, but the free energy of small clusters is higher than the result of classical nucleation theory, in contrast to what one expects from Tolman-like corrections. We interpret these results, deriving low-temperature series expansions for very small clusters, thus showing that the capillarity approximation both underestimates the surface energy and overestimates the surface entropy of very small clusters. Finally, we use our results to give a speculative explanation of recent nucleation experiments. The dependence of the cluster diffusivity on cluster size is tentatively explained in terms of a crossover between two mechanisms yielding different power laws.

MATHEMATICAL PHYSICS

26645 Numerical integration of the Langevin equation: Monte Carlo simulation. Ermak, D.L.; Buckholz, H. (Environmental Sciences Division, Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *J. Comput. Phys.;* **35**: No. 1, 169-182(Apr 1980).

Monte Carlo simulation techniques are derived for solving the ordinary Langevin equation of motion for a Brownian particle in the presence of an external force. These methods allow considerable freedom in selecting the size of the time step, which is restricted only by the rate of change in the external force. This approach is extended to the generalized Langevin equation which uses a memory function in the friction force term. General simulation techniques are derived which are independent of the form of the memory function. A special method requiring less storage space is presented for the case of the exponential memory function.

26646 Observations on the two-body relativistic wave equation. Zemach, C. (Los Alamos Scientific Lab., NM (USA)). *Physica, A;* **96**: No. 1-2, 350-358(Apr 1979).

The solution and applications of the Bethe-Salpeter equation are discussed. (W.D.L.).

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

26647 (DOE/ET/53036—16) Direct ohmic heating of positive ions in tokamak plasmas. Ware, A.A. (Texas Univ., Austin (USA). Fusion Research Center). Mar 1980. Contract AC05-76ET53036. 25p. NTIS, PC A02/MF A01.

In this paper, two mechanisms are reported which will transfer part of the ohmic heat from the electrons to the ions. Here the direct ohmic heating of the ions is considered; an accompanying paper considers the magnetic pumping cooling of the electrons and associated magnetic pumping heating of the ions caused by the poloidal rotation of the plasma. Typically, both mechanisms can cause rates of energy transfer which are of the same order of magnitude as the collisional transfer and are therefore important corrections to be considered in both electron and ion energy containment calculations.

26648 (EPRI-AP—1351) Conceptual design of RST - an rf-driven, steady-state tokamak. Prater, R.; Bhadra, D.; Bikadi, L. (General Atomic Co., San Diego, CA (USA)). Mar 1980. 251p. NTIS, PC A12/MF A01.

The preliminary conceptual design is described of RST, a radio frequency driven, steady-state tokamak. The function of RST is to develop the physics and engineering bases for the development of the tokamak as a true steady-state reactor. The physics of rf current drive, using a variety of electromagnetic waves, is discussed. The device makes use of a novel superconducting toroidal magnetic field coil concept, in which the axial current is carried in only three return legs, and superconducting pullback coils are used to reduce the magnetic field ripple. This technique greatly increases access to the plasma. Impurity control by means of edge cooling, bundle divertor, and rf wave momentum sources is discussed, as well as fueling.

26649 (GA-A—15771) Energy confinement in Doublet III with high-Z limiters. Marcus, F.B.; Adcock, S.J.; Baker, D.R.; Blau, F.P.; Brooks, N.H.; Chase, R.P.; DeBoo, J.C.; Ejima, S.; Fairbanks, E.S.; Fisher, R.K. (USAEC Regulatory Staff, Washington, DC). Feb 1980. Contract EY-76-C-03-0167M038. 52p. NTIS, PC A04/MF A01.

This report describes the experimental measurements and data analysis techniques used to evaluate the energy confinement in noncircular plasmas produced in Doublet III. Major aspects of the confinement measurements and analysis techniques are summarized. Machine parameters, diagnostic systems and discharge parameters relavent to the confinement measurements are given. Magnetic analysis techniques used to determine the plasma shape are reviewed. Scaling of the on-axis values of electron temperature, confinement time and Z/sub eff/ with plasma density is presented. Comparison with scaling results from other circular tokamaks is discussed. Numerical and analytic techniques developed for calculating the plasma energy confinement time and self-consistent profiles of density, temperature, current, and flux in non-circular geometries are described. These techniques are applied to the data and used to determine the central and global electron energy confinement time for a typical doublet plasma. Additional aspects of the confinement such as the radial dependence of the electron thermal conductivity and the estimated ion temperature are explored with the aid of a non-circular transport simulation code. The results of the confinement measurements are summarized and discussed. A brief summary of the theoretically expected effects of noncircularity on plasma confinement is included for reference as Appendix I.

26650 (PPPL—1661) Status report of the fusion alpha confinement test, March 1980. Grisham, L.R.; Post, D.E.; Weisheit, J.C.; Eubank, H.P.; Mikkelsen, D.R.; Stewart, L.D. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract AC02-76CH03073. 67p. NTIS, PC A04/MF A01.

The Fusion Alpha Confinement Test (FACT) investigates the ability of tokamaks and other magnetic devices to confine fusion-produced alpha particles and be heated by them. This report summarizes the progress made since the initial conception, and lists and discusses the remaining unresolved issues. Preliminary results are given for two experiments at the Lawrence Berkeley Laboratory (LBL) in which He^- currents of 30 mA and 69 mA, respectively, were obtained from two different ion sources. A number of atomic physics issues relevant to the utility of He^- as a source for He^0 are discussed, and a review of considerations for HeH^+ and Li^- accelerators is presented.

26651 (SAI—023-80-352-LJ) Relativistic theory of electron cyclotron resonance heating. Bernstein, I.B.; Baxter, D.C. (Yale Univ., New Haven, CT (USA); Science Applications, Inc., La Jolla, CA (USA)). May 1980. Contract EY-76-C-03-1018. 87p. (LAPS—68). NTIS, PC A05/MF A01.

The formal theory of the interaction of mildly relativistic electrons with a cyclotron resonant applied electromagnetic field described by geometric optics is developed. The electron distribution function is written as the sum of a quasi-static part F_0 and a high frequency part f_1. A quasi-linear theory is employed to describe these. The resulting transport equation f_0 is written to lowest significant order jointly in the reciprocal of the gyration frequency and the bounce frequency. It includes a relativistic collision term and a drag term associated with synchrotron emission. The linearized equations for f_1 are solved and an expression for the high frequency current derived.

26652 Exact Vlasov equilibria for field-reversing rings. Channell, P.J. (The Institute for Advanced Study, Princeton, New Jersey 08540). EY-76-S-02-3237. *Phys. Fluids;* **23**: No. 6, 1263-1267(Jun 1980).

A technique is developed for finding exact Vlasov equilibria for field-reversing rings. An infinite class of equilibria can be generated in which the plasma is confined to a finite region of space. A variety of ring cross sectional shapes can be found.

26653 Numerical studies of new stellarator concepts. Bauer, F.; Betancourt, O.; Garabedian, P. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). EY-76-C-02-3077. *J. Comput. Phys.;* **35**: No. 2, 341-355(May 1980).

A three-dimensional computer code has been developed to study the magnetohydrodynamic equilibrium and stability of a diffused or sharp boundary plasma in toroidal geometry. It is shown how equilibria with net toroidal current identically zero can be determined and how growth rates of instabilities can be calculated. Applications are made to an $l=2$, 3 stellarator configuration that offers the possibility of achieving a critical value as high as 10% for the plasma parameter β.

26654 Electrostatic plasma-confinement experiments in a tandem mirror system. Coensgen, F.H.; Anderson, C.A.; Casper, T.A.; Clauser, J.F.; Condit, W.C.; Correll, D.L.; Cummins, W.F.; Davis, J.C.; Drake, R.P.; Foote, J.H.; Futch, A.H.; Goodman, R.K.; Grubb, D.P.; Hallock, G.A.; Hornady, R.S.; Hunt, A.L.; Logan, B.G.; Munger, R.H.; Nexsen, W.E.; Simonen, T.C.; Slaughter, D.R.; Stallard, B.W.; Strand, O.T. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 17, 1132-1135(28 Apr 1980).

Results from the tandem mirror experiment are described. The configuration of axial density and potential profiles are created and sustained by neutral-beam injection and gas fueling. Plasma confinement in the center cell is shown to be improved by the end plugs by as much as a factor of 9. The electron temperature is higher than that achieved in our earlier 2XIIB single-cell mirror experiment.

26655 Effect of wall corrugations on the lower hybrid wave spectrum of a waveguide array. Shcherbinin, O.N.; Schuss, J.J. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). *Nucl. Fusion;* **19**: No. 12, 1675-1678(Dec 1979).

The effect of wall corrugations on the lower hybrid wave spectrum of a waveguide array is investigated in a linear approach for the conditions of the Alcator A experiment. It was found that a limited number of grooves placed on both sides of a two-waveguide grill can considerably alter the wave power spectrum launched into

the plasma. However, if the set of the grooves is situated further than one wavelength from the grill its influence on the wave power spectrum is weak.

26656 **Phase measurements of fast wave toroidal eigenmodes.** Knox, S.O. Lubbock, TX; Texas Tech Univ. (1979). 99p. University Microfilms Order No. 79-20,376.

Thesis (Ph. D.).

It is generally accepted that the tokamak fusion reactor scheme will require supplementary heating energy in order to reach thermonuclear ignition temperatures. One very promising method of supplying this energy is to use radio-frequency waves. An experiment is discussed where phase-resolved techniques were used to investigate the resonance, or eigenmodes, formed when a radio-frequency wave (the fast Alfven wave) propagates in a toroidal plasma. A resonant structure is formed where the parameters of the plasma and the rf excitation frequency plus the physical dimensions of the torus determine where the eigenmodes occur. At an eigenmode, the radio-frequency wave amplitude in the plasma greatly increases due to the buildup of oscillations within the torus.

26657 **Investigations of nonneutral magnetically confined electron plasmas.** Eckhouse, S. Irvine, CA; Univ. of California (1978). 255p. University Microfilms Order No. 79-01,959.

Thesis (Ph. D.).

An experimental investigation of nonneutral electron clouds confined in magnetic mirrors has been conducted. Two methods of electron injection into the mirror were developed. In both methods a thermionic injector with its filament parallel to the magnetic field is used and electrons are injected across field lines. In the first method the injector is located at the mirror midplane. In the second method the injector is located between the mirrors but close to one of the mirror maxima. Collective effects play an important role in the two cases.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 26276, 26695

26658 (LBL—10913) **Evaluation of two-beam spectroscopy as a plasma diagnostic.** Billard, B.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 212p. NTIS, PC A10/MF A01.

Thesis.

A two-beam spectroscopy (TBS) system is evaluated theoretically and experimentally. This new spectroscopic technique uses correlations between components of emitted light separated by a small difference in angle of propagation. It is thus a non-perturbing plasma diagnostic which is shown to provide local (as opposed to line-of-sight averaged) information about fluctuations in the density of light sources within a plasma - information not obtainable by the usual spectroscopic methods. The present design is an improvement on earlier systems proposed in a thesis by Rostler.

26659 **Stimulated Brillouin rescattering.** Speziale, T.; McGrath, J.F.; Berger, R.L. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). DE-AC08-78DP 40030. *Phys. Fluids;* **23**: No. 6, 1275-1277(Jun 1980).

Rescattering of stimulated Brillouin scattered light is investigated. The net reflection coefficient for light scattered by a plasma slab is calculated and compared with the single scatter result.

26660 **Observations of enhanced ion acoustic fluctuations in CO_2 laser-produced plasmas.** Hazelton, R.C. Fort Collins, CO; Colorado State Univ. (1978). 122p. University Microfilms Order No. 79-01,870.

Thesis (Ph. D.).

A significant commitment has been made to produce controlled thermonuclear reactions using laser radiation to confine and heat a pellet containing a mixture of deuterium and tritium. Therefore an understanding of the interactions between the incident laser radiation and the plasma formed around the pellet is necessary before an efficient thermonuclear power station can become a reality. Of basic concern are the plasma instabilities which may be excited and the effects these instabilities have upon energy deposition in the plasma and on the transport properties of the plasma. To add to the understanding of laser-plasma interactions, CO_2 laser produced plasmas in a background gas are diagnosed by means of Thomson scattering of ruby laser radiation. Holographic interferometry and schlieren photograhy are auxiliary techniques used to determine electron densities and plasma expansion velocities, respectively. With these techniques ion density fluctuations and electron temperatures have been measured in hydrogen and deuterium plasmas.

PLASMA KINETICS - EXPERIMENTAL

26661 (CONF-790775—) **Proceedings of the workshop on sputtering caused by plasma (neutral beam) surface interaction.** (Argonne National Lab., IL (USA); Department of Energy, Washington, DC (USA). Office of Fusion Energy). Apr 1980. Contract W-31-109-ENG-38. 202p. NTIS, PC A10/MF A01.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

Separate abstracts were prepared for 7 of the 16 included sections. Title listings are given for the remaining papers. (MOW)

26662 (CONF-790775—, pp 1.1-1.4) **Sputtering data requirements for tokamak transport codes.** Singer, C.E.; Post, D.E. (Princeton Univ. Plasma Physics Lab., NJ). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

The requirements of tokamak transport codes for sputtering data can be summarized as follows. Sputtering data must be provided which are relevant to working tokamak environments. In order of decreasing importance, the required data are total sputtering yields for a variety of materials bombarded by hydrogenic ions and typical tokamak impurities with energies from 0.1 to 1 keV, and possibly for hydrogenic ions from 20 to 100 keV/amu, energy distribution of sputtered atoms, angular distribution of sputtered atoms, and species composition in any rare case where neutral atoms are not the dominant species sputtered. This data is used to analyze and predict impurity behavior in current and future large tokamaks, and to try to find ways to minimize the impurity levels in the discharge. Sputtering of the wall and limiter by charge-exchanged neutrals, untrapped beam ions and neutrals, and ions at the plasma edge is a real and potentially lethal source of impurities. Accurate sputtering data will assist in the quantitative understanding of impurity source mechanisms.

26663 (CONF-790775—, pp 2.1-2.2) **Sputtering data needs for modelling tokamak transport in high beta experiments.** Hogan, J.T. (Oak Ridge National Lab., TN). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26664 (CONF-790775—, pp 3.1-3.5) **Plasma impurity and buildup in mirror devices.** DeVoto, R.S. (Lawrence Livermore Lab., CA). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26665 (CONF-790775—, pp 4.1-4.9) **Needs for sputtering data in fusion reactor design.** Emmert, G.A. (Univ. of Wisconsin, Madison). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26666 (CONF-790775—, pp 5.1-5.10) **Experimental observations of sputtering in tokamaks.** Dylla, H.F. (Princeton Plasma Physics Lab., NJ). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

There is qualitative evidence to indicate that ion sputtering within the scrape-off plasma and, to a lesser extent, charge exchange sputtering of the vacuum vessel wall are significant mechanisms for high Z impurity contamination of plasmas in present generation tokamaks. A quantitative correlation of tokamak impurities with sputtering effects will require more extensive impurity studies of the edge plasma. High power neutral beam injection will enhance a number of sputtering effects within the bulk plasma. Intrinsic neutral beam impurities are most likely the result of sputtering effects within the ion source.

26667 (CONF-790775—, pp 6.1-6.6) **Surface erosion due to sputtering.** Cecchi, J.L. (Princeton Plasma Physics Lab., NJ). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

The estimated rates of erosion due to sputtering in various classes of tokamak fusion devices are summarized. The only situation in which macroscopic erosion will occur is in reactor-like devices where ion sputtering of the limiter/divertor will result in an erosion rate of >1 cm/yr and charge exchange neutral sputtering of the first wall could cause erosion at a rate as high as 5 mm/yr. In reactor devices smaller rates of erosion, which could be important for coated components, will occur due to neutral beam bombardment of protective plates ($\sim$ .2 mm/yr). In near term devices, such as TFTR, ion sputtering of the limiter/divertor will cause $\sim$ 20 μm/yr of erosion, while neutral beam sputtering of the protective plates will result in a $\sim$ 2 μm/yr rate. For present devices erosion due to sputtering is negligible.

26668 (CONF-790775—, pp 7.1-7.19) **Light ion sputtering yields.** Roberto, J.B. (Oak Ridge National Lab., TN). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

The existing experimental data and empirical relationships for low-energy light ion sputtering are adequate for factor-of-two estimates of total yields in all materials and compounds where the sputtering is determined by collisional effects. For higher energy

light ions (E > 10 keV), existing theories predict the correct energy dependence of the sputtering but overestimate the yields by factors of as much as ten in some cases. Angle of incidence effects have not been studied extensively but the available data can be modeled adequately using transport theories. Temperature effects are unimportant in collisional sputtering by light ions. Overall, physical sputtering yields by light ions are understood adequately for the present needs of the fusion community with the exception of additional experimental measurements for specific materials at low doses and in the high energy region.

26669 (CONF-790775—, pp 8.1-8.9) **Sputtering by plasma impurity ions (Z > 2).** Smith, J.N. Jr. (General Atomic Co., San Diego, CA). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

Information on the sputtering of prospective first wall/limiter/divertor materials by heavy impurity ions such as Cr^+, Ni^+, Fe^+, Cu^+, Ti^+, Mo^+, W^+, Ta^+, C^+, O^+, N^+; etc., is described. While estimates to within a factor of 2 to 4 can be made from rare gas data or extant theory in many cases, supporting data for heavy impurity ions is required as a function of: (1) energy from about 1 to 5 keV, (2) dose rate, at least to high enough dose rates to establish the threshold for non-linear effects, if any, (c) target temperature up to temperatures beyond which mechanical properties degrade, (d) incident angle, and (e) surface morphology and contamination.

26670 (CONF-790775—, pp 9.1-9.25) **Energy and mass distributions of sputtered particles.** Krauss, A.R.; Wright, R.B. (Argonne National Lab., IL). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

This review is primarily concerned with aspects of sputtering as they relate to plasma contamination of a magnetically confined fusion device. Experimental methods used to study secondary ions are quite distinct from those used to study sputtered neutrals. The results are dissimilar and the significance for plasma impurity levels is quite different. For this reason, the data has been divided into four categories: (1) energy distributions of neutral sputtered particles, (2) energy distributions of secondary ions, (3) mass spectra of sputtered neutrals and (4) mass spectra of secondary ions. The existing (June 1979) relevant data are summarized.

26671 (CONF-790775—, pp 10.1-10.8) **Angular distribution of sputtered particles.** Kaminsky, M. (Argonne National Lab., IL). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26672 (CONF-790775—, pp 11.1-11.13) **Reactive sputtering and chemical erosion.** Rye, R.R. (Sandia Labs., Albuquerque, NM). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

Concentration has been on those chemical processes that lead to removal of wall material and not on how these processes affect other problem areas such as permeation, conductivity, etc. For chemical effects the main consideration has to be given to the active forms of hydrogen, both from the standpoint of incident particle flux and inherent chemical reactivity. This restricts the range of materials one needs to consider, however, to materials containing atoms from the right hand side of the periodic table, since few metal hydrides are volatile. Trace impurities, where known, have to be considered from the standpoint of their potential ability to modify the surface and thus change the physical sputtering yield. The chemical effects that have been summarized here clearly show that one cannot simply ask what is the sputtering yield of pure material x with particle y. The results are too critically dependent on the surface composition.

26673 (CONF-790775—, pp 12.1-12.21) **Synergisms in sputtering and blistering of surfaces.** Wilson, K.L.; Bauer, W. (Sandia Labs., Livermore, CA). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

In the evaluation of impurity introduction, a consideration is the effect of surface alteration on the physical sputtering yield. Synergistic effects of this type considered in this review include surface roughness and gas (H and He) loaded surfaces. In addition, the effects of sputtering on He induced blistering are also assessed.

26674 (CONF-790775—, pp 13.1-13.7) **Neutron sputtering.** Kaminsky, M. (Argonne National Lab., IL). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26675 (GA-A—15821) **Status of impurity studies in Doublet III.** (General Atomic Co., San Diego, CA (USA); Japan Atomic Energy Research Inst., Tokyo). Mar 1980. Contract AT03-76ET51011. 23p. (CONF-800455—10). Dep. NTIS (US Sales Only), PC A02.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Recent impurity results obtained in Double III (R = 1.43 m, a = 0.45 m) are summarized. Topics discussed include wall composition measurements, the effect of plasma edge temperature on impurity influx, and the role of MHD activity in determining whether or not impurities concentrate near the plasma axis. Macroscopically similar discharges with and without central impurity peaking are described and compared. The peaked discharges have a Z/sub eff/ profile that is peaked on axis, a hollow current density profile and a double valued q-profile. The latter results in the sudden onset of a large amplitude internal MHD mode that reverses the impurity peaking.

26676 (ORNL/TM—7259) **High-resolution spectral analysis of light from neutral beams and ion source plasmas.** McNeill, D.H.; Kim, J. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 39p. NTIS, PC A03/MF A01.

The spectral distributions of Balmer alpha emission from 7- and 22-cm-diam neutral hydrogen beams have been measured with a Fabry-Perot interferometer to obtain information on the beam energy, divergence, and species composition. Results of these measurements are compared with other data on the beam properties to evaluate high-resolution spectroscopy as a beam diagnostic technique. Measurements on ion source plasmas and on beam-produced background plasmas yield average neutral atom energies of approximately 0.3 and 2.5 eV, respectively.

26677 (ORNL/TM—7283) **Ion energy recovery experiment based on magnetic electro suppression.** Kim, J.; Stirling, W.L.; Dagenhart, W.K.; Barber, G.C.; Ponte, N.S. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 32p. NTIS, PC A03/MF A01.

A proof-of-principle experiment on direct recovery of residual hydrogen ions based on a magnetic electron suppression scheme is described. Ions extracted from a source plasma a few kilovolts above the ground potential (~ 20 A) are accelerated to 40 keV by a negative potential maintained on a neutralizer gas cell. As the residual ions exit the gas cell, they are deflected from the neutral beam by a magnetic field that also suppresses gas cell electrons and then recovered on a ground-potential surface. Under optimum conditions, a recovery efficiency (the ratio of the net recovered current to the available full-energy ion current) of 80% +- 20% has been obtained. Magnetic suppression of the beam plasma electrons was rather easily achieved; however, handling the fractional-energy ions originating from molecular species (H_2^+ and H_3^+) proved to be extremely important to recovery efficiency.

26678 **Titanium density measurements in the PDX tokamak using a Ti XVII forbidden line.** Suckewer, S.; Hinnov, E.; Bol, K. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nucl. Fusion;* **19**: No. 12, 1681-1683(Dec 1979).

A spectrum line observed at 3834.4+-0.2A and identified as a $2s^22p^2\ {}^3P_2 \rightarrow {}^3P_1$ magnetic dipole transition in the Ti XVII ground configuration was used for titanium density measurements in the Poloidal Divertor Experiment (PDX).

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 26700, 26724

26679 (CONF-790775—, pp 14.1-14.29) **Sputtering: theory-modelling.** Haggmark, L.G. (Sandia Labs., Livermore, CA). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26680 (CONF-790775—, pp 15.1-15.9) **Analytical expressions: physical sputtering.** Smith, D.L. (Argonne National Lab., IL). Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26681 (CONF-790775—, pp 16.1-16.7) **TRIM-neutron-sputtering calculations.** Biersack, J.P. (Hahn-Meitner Inst., Berlin, Germany); Riccato, A.; Kaczerowski, W. Apr 1980.

From Workshop on sputtering caused by plasma (neutral beam) surface interactions; Argonne, IL, USA (9 Jul 1979).

26682 (CONF-800607—52) **Plasma physics aspects of ETF/INTOR.** Peng, Y.K.M.; Rutherford, P.R.; Schmidt, J.A.; Cohn, D.R.; Miller, R.L. (Oak Ridge National Lab., TN (USA); Princeton Univ., NJ (USA). Plasma Physics Lab.; Massachusetts Inst. of Tech., Cambridge (USA); General Atomic Co., San Diego, CA (USA)). 1980. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

In order to achieve their principle technical objectives, the Engineering Test Facility (ETF) and the International Tokomak

Reactor (INTOR) will require an ignited (or near ignited) plasma, sustained for pulse lengths of at least 100 secs at a high enough plasma pressure to provide a neutron wall loading of at least 1.3 MW/m^2. The ignited plasma will have to be substantially free of impurities. Our current understanding of major plasma physics characters is summarized.

26683 (MSNW—80-1146-2) **Numerical modelling of an end-plugged theta pinch.** Milroy, R.D.; Steinhauer, L.C. (Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)). Apr 1980. Contract AC06-76ET53027. 43p. NTIS, PC A03/MF A01.

Analytical and numerical studies of an end-plugged theta pinch are described. The analytical mode treats the ablated plug plasma in the quasistatic limit where radiation losses balance energy flowing from the main plasma. This model is used to calculate the enhancement in energy confinement due to an ablating end plug for various plug species. The numerical model employs a one-dimensional, time-dependent magnetohydrodynamic code. Results of calculations simulating the Scylla IV-P end-plugged theta pinch experiment are presented. The calculations achieve reasonable agreement with experiment except for certain notable discrepancies, believed to spring from two-dimensional effects.

26684 (MSNW—801146-1) **Kinetic-theory description of electron heat transfer in a plasma.** Shirazian, M.H.; Steinhauer, L.C. (Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)). Apr 1980. Contract AC06-76ET53027. 45p. NTIS, PC A03/MF A01.

Electron heat flux in a fully ionized gas between two parallel boundaries, separated by a distance L, is studied. Two full-range moment methods with the assumption of a two-sided distribution function are employed to analyze the relation between the electron heat flux and the plasma collisionality parameter L/λ/sub ei/, both with and without electron-electron collisions (λ/sub ei/ is the electron-ion collision mean-free-path). The electron heat flux compared to free convective flux and the continuum heat flux is determined as a function of L/λ/sub ei/, over the entire range from free flow to continuum regimes.

26685 **Particle stochasticity due to magnetic perturbations of axisymmetric geometries.** Mynick, H.E.; Krommes, J.A. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Fluids;* **23**: No. 6, 1229-1237(Jun 1980).

The quasi-linear theory of collisionless test particle diffusion in stochastic magnetic fields is extended to include the effects of finite gyroradius rho and particle drifts (including magnetic trapping). A canonical framework is used, in which both the criterion for onset of stochasticity and the diffusion tensor scale with field-particle coupling coefficients g/sub l/. The g/sub l/ contain all the information about the unperturbed orbit of a given particle and the perturbation fields with which the particle interacts. The modification of transport due to finite rho and drifts is thus found by comparison of the g/sub l/ including these effects to their driftless, rho→0 limit. It is found that runaway electron confinement is substantially improved over earlier, driftless estimates, and that trapped particles in microturbulence ought not be stochastic. The perturbations from proposed ripple injection schemes are large enough to induce stochasticity for certain classes of particles.

26686 **Classical collisional theory of beam-driven plasma currents.** Hirshman, S.P. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Fluids;* **23**: No. 6, 1238-1243(Jun 1980).

A variational calculation of the current produced in a plasma by fast beam particles is presented. A new energy polynomial expansion of the classical Spitzer function is obtained and used to derive an accurate analytic expression for the beam-driven current j/sub parallel/, which includes the effects of electron-electron collisions and is valid for all values of v-bar/sub b/=v/sub b//v/sub e/ and effective charge Z-bar. This analytic result is in excellent agreement with previous numerical calculations. An accurate rational form for the beam-driven current as a function of beam velocity is obtained by patching the large and small v-bar/sub b/ asymptotic expansions of j/sub parallel/.

26687 **Analytic approximation to resonant plateau transport coefficients for tandem mirrors.** Cohen, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Fusion;* **19**: No. 12, 1579-1585(Dec 1979).

Analytic approximations to resonant plateau diffusion coefficients for ions in a tandem mirror solenoid are developed. These are obtained by assuming that the (nabla)B azimuthal drift is small compared to E vector x B vector contribution, and that the radial drift per bounce is determined by properties of the vacuum magnetic field. The resulting expressions are used to estimate radial transport life-times for the Lawrence Livermore Laboratory Tandem Mirror Experiment (TMX) and for a proposed future experiment, MFTF-B. These estimates indicate radial loss comparable to axial for TMX, but smaller than axial for most operating modes considered for MFTF-B.

26688 **Neoclassical transport in Elmo Bumpy Torus (EBT).** Hazeltine, R.D. (Texas Univ., Austin (USA). Dept. of Physics); Krall, N.A.; Klein, H.H.; Catto, P.J. (Science Applications, Inc., La Jolla, CA (USA)). *Nucl. Fusion;* **19**: No. 12, 1597-1604(Dec 1979).

The calculation in this paper clarifies the ordering of transport regimes in Elmo Bumpy Torus (EBT), identified as one collisional and two collisionless regimes, plateau and banana. Explicit analytic estimates of the transport rates in the plateau regime are obtained.

26689 **Radial transport in the Elmo Bumpy Torus in collisionless electron regimes.** Jaeger, E.F.; Hedrick, C.L.; Spong, D.A. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **19**: No. 12, 1627-1634(Dec 1979).

One important area of disagreement between radial transport theory and the ELMO Bumpy Torus (EBT) experiment has been the degree of collisionality of the toroidal plasma electrons. Experiment shows relatively warm electrons (kTsub(e) approximately 300-600eV) and collisionless scaling, i.e. energy confinement increasing with temperature. But results of early one-dimensional (1-D), neoclassical transport models with radially inward pointing electric fields are limited to relatively cool electrons (kTsub(e) approximately 100-200eV) and collisional scaling. In this paper these early results are extended to include lowest-order effects of ion diffusion in regions where poloidal drift frequencies are small. The effects of direct, or non-diffusive, losses in such regions are neglected along with the effects of finite radial electric fields on electron transport coefficients and of self-consistent poloidal electric fields on ion transport coefficients. Results show that solutions in the collisionless electron regime do exist. Furthermore, when the effects of finite electron ring beta on magnetic fields near the plasma edge are included, these solutions occur at power levels consistent with experiment.

26690 **Impurity control by neutral-beam injection.** Stacey, W.M. Jr. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering); Sigmar, D.J. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **19**: No. 12, 1665-1673(Dec 1979).

A recently developed generalization of neoclassical theory is applied to study the use of neutral-beam injection to drive impurities out of a tokamak plasma. The theory accounts for the direct momentum exchange between beam and plasma, which has been studied previously, and also for the effects of the beam in altering the first-order particle flows and the ambipolar potential. Conditions are established for which co-injection drives impurity fluxes outward. It is estimated that order-unity changes of the radial impurity flow should be found in current experiments and that modest levels of neutral-beam injection should suffice for impurity control in reactors. In the course of this work, the general theory of particle transport in the presence of particle and momentum sources is evaluated for a two-species plasma with arbitrary plasma geometry and beta.

26691 **Re-entrant boundary conditions for toroidal transport and diffusion.** Daniel, R.; Pomraning, G.C. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). *Ann. Nucl. Energy;* **6**: No. 7-8, 405-416(1979).

Exact re-entrant boundary conditions are formulated for toroidal geometry with a circular cross section in both transport and diffusion theory. For a small inverse aspect ratio epsilon, both boundary conditions are put in a form well suited for use in computer calculations in toroidal geometry. It is shown that the integral of the scalar flux over the torus has a toroidal correction of order epsilon due to re-entrant particles. This is in contrast to the inherent toroidal effect in the transport equation itself which gives an $epsilon^2$ toroidal contribution to the integrated flux. Numerical results are presented for a model diffusion problem which give an indication of the magnitude of the re-entrant current contribution to the integrated flux. (author).

26692 **Numerical simulation studies of toroidal pinches.** Park, W. New York, NY; Columbia Univ. (1978). 156p. University Microfilms Order No. 79-08,627.

Thesis (Ph. D.).

A time dependent two-dimensional MHD calculation for pinch experiments, previously developed at Columbia, is improved and modified so that very long calculations (until the plasma reaches a quasi-equilibrium state) are possible. The calculation method is presented, and the simulation results of the Jutphaas screw pinch SP-1 and the Los Alamos reverse-field pinches ZT-I, ZT-S, and ZT-40 are studied. A set of single fluid resistive MHD equations are solved using standard alternate direction implicit method in an Eulerian difference scheme. Initial conditions correspond to the start of the main discharge in the experiment, with a homogeneous fully ionized plasma at rest. The equations are driven by time dependent boundary

conditions: the toroidal magnetic field and the poloidal flux at the wall.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 26498

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 26653, 26703

26693 (ORNL/TM—7281) **Effects of toroidal coupling on the stability of tearing modes.** Carreras, B.; Hicks, H.R.; Lee, D.K. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 64p. NTIS, PC A04/MF A01.

The time evolution of tearing modes in toroidal geometry is studied in the low-β and large aspect ratio limit. An initial value three-dimensional computer code, which numerically advances the reduced set of resistive magnetohydrodynamic equations is employed. Toroidicity has, in general, a destabilizing effect on tearing modes in this limit. A generalization of the Δ' formalism can be used to study the linear regime. The results obtained in this way are in very good agreement with the results from the initial value code. The nonlinear phase of the evolution is also followed numerically. In the case of strong interaction of different helicities, a larger region of stochastic magnetic field lines results than in the cylindrical geometry case.

26694 (PPPL—1655) **Resistive instabilities and field line reconnection.** White, R.B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract EY-76-C-02-3073. 147p. NTIS, PC A07/MF A01.

A review is given of the linear theory of reconnection for a plane current layer. The three basic modes are the Rippling Mode, the Gravitational Interchange Mode, and the Tearing Mode. A derivation is given of the magnetic field energy which provides the driving force for the tearing mode. The necessary concepts for the analysis of tearing modes in cylindrical geometry are introduced. The equations governing tearing mode evolution in a tokamak are expanded to lowest order in the inverse aspect ratio. The tearing mode in a toroidal device is closely related to the ideal magnetohydrodynamic kink mode, and this relationship is stressed in the derivations of the linear growth rates for modes with poloidal model number $m > 2$ and for the quite different $m = 1$ mode. The nonlinear theory of tearing mode development and the implications of this theory for the understanding of toroidal magnetic confinement devices is reviewed.

26695 **Observation of shock-generated turbulence in a magnetized plasma by CO_2 laser scattering.** Gold, S.H.; DeSilva, A.W.; Huba, J.D. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **23**: No. 6, 1132-1141(Jun 1980).

Small angle CO_2 laser scattering is used to sense density fluctuations produced by microinstabilities in a collisionless plasma driven by a magnetic implosion in a high voltage theta pinch. Turbulent density fluctuations are measured at a wavelength near the Debye length within and behind the current sheet of the imploding shock. Two main scattering features are found. The earlier feature, occurring at the leading edge of the current sheet, is only about 30 nsec wide and is narrowly radial. It appears to be driven by ions reflected from the shock front and is believed due to an ion beam driven electron cyclotron instability. The later feature, peaking about 70 nsec after the first, is broader in time and has a maximum rotated about 25° from the azimuthal (current sheet) direction, with a half-width of 40°. It appears to be due to the ion acoustic instability, driven by relative drift of electrons and ions in the current sheet.

26696 **Bifurcation and "strange" behavior in instability saturation by nonlinear three-wave mode coupling.** Wersinger, J.; Finn, J.M.; Ott, E. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **23**: No. 6, 1142-1154(Jun 1980).

A simple model of nonlinear saturation of an unstable mode is studied. The model consists of the resonant three-wave coupling equations with the highest frequency wave linearly unstable and the two lower frequency waves damped. As the damping of the stable waves is increased, the solutions go through an interesting succession of qualitative changes, including bifurcations to increasingly complex periodic solutions and the appearance of apparently chaotic (i.e., aperiodic) solutions. These qualitative features are shown to be explainable on the basis of a one-dimensional mapping which is numerically derivable from the original system of differential equations.

26697 **Two-dimensional analysis of trapped-ion eigenmodes.** Marchand, R.; Tang, W.M.; Rewoldt, G. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Fluids;* **23**: No. 6, 1164-1181(Jun 1980).

The first fully two-dimensional eigenmode analysis of the trapped-ion instability in an axisymmetric toroidal geometry is presented. The poloidal structure is taken into account by Fourier-expanding the perturbed electrostatic potential, phi, in θ. Assuming that the perturbation varies mildly over a typical ion-banana-width, rho/sub b/i, each poloidal harmonic is expressed as a truncated Taylor series in the minor radius to account for the radial structure. The resulting set of coupled ordinary second-order differential equations is solved numerically by the method of finite elements. The formalism is also applicable to the radially local and one-dimensional radial approximations. Results obtained in these limits are presented and found to be in reasonable agreement with previous calculations. In low shear plasmas, the full two-dimensional calculation is in qualitative agreement with the one-dimensional radial approximation. However, for higher shear the two-dimensional calculation yields a somewhat different picture for the radial structure of the instability. The analysis presented is limited to long radial wavelength and electrostatic perturbations.

26698 **Electron temperature gradient driven microtearing mode.** Gladd, N.T.; Drake, J.F.; Chang, C.L.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **23**: No. 6, 1182-1192(Jun 1980).

The linear stability theory of an electron temperature gradient driven microtearing mode, an instability recently proposed as a possible cause for anomalous electron thermal transport in tokamaks, is considered. The theory is electromagnetic and is carried out within the context of a slab model with a sheared magnetic field. In contrast to the linear theory of drift waves, where any magnetic shear is completely stabilizing, shear may actually increase the growth rate of microtearing modes. The crucial feature required for instability is the energy dependence of electron-ion collisions. The mode is shown to be unstable for electron temperature gradients and degrees of collisionality typical of present day tokamaks. It is found that previous theories of these modes were based on assumptions which are not, in general, justified; a case in point being the fact that the usually neglected electrostatic effects are actually quite important in producing instability.

26699 **Wave-particle transport from electrostatic instabilities.** Gary, S.P. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **23**: No. 6, 1193-1204(Jun 1980).

The second-order theory for electrostatic microinstabilities driven by currents both across and parallel to a uniform magnetic field in a Vlasov plasma is considered. Both electrons and ions are taken as magnetized, and propagation is in the plane defined by the drift velocities and the magnetic field. A consistent procedure is used to compare wave-particle exchange frequencies of momentum and energy for the lower hybrid density drift, ion cyclotron electron density drift, universal density drift, ion acoustic current, and ion cyclotron current instabilities. In this model, resistivities and heating frequencies of the universal instability are substantially greater than those due to the other drift modes, and wave-particle transport due to the ion cyclotron electron density drift instability is larger than that of the lower hybrid density drift instability at T/sub e/>T/sub i/.

26700 **Kinetic equations for low frequency instabilities in inhomogeneous plasmas.** Antonsen, T.M. Jr.; Lane, B. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **23**: No. 6, 1205-1214(Jun 1980).

Kinetic equations for low frequency, short perpendicular wavelength, electromagnetic perturbations in an inhomogeneous, magnetically confined plasma are developed. The analysis makes use of the recently developed high toroidal mode number expansion to reduce the lowest-order system of equations to a set of ordinary (along the field line) integro-differential equations. Included in these equations are the effects of finite Larmor radius, magnetic shear, trapped particles, and nonuniform magnetic curvature drifts. Perturbed fields are represented by a scalar potential and two components of the vector potential. Thus, the effects of the compressional component of the perturbed magnetic field are retained and the equations are valid for arbitrary values of the plasma pressure. The extension of the high toroidal mode number expansion to nonaxisymmetric configurations is discussed.

26701 **Disruptive MHD activity during plasma current rise in Alcator A tokamak.** Granetz, R.S.; Hutchinson, I.H.; Overskei, D.O. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). *Nucl. Fusion;* **19**: No. 12, 1587-1595(Dec 1979).

During the current rise phase of the Alcator A discharge a series of disruptions occurs, related to MHD activity of poloidal periodicity m, at limter q-values approximately 1.6m (m integral). The electron temperature profile is peaked at the centre throughout. It is shown, however, that current diffusion with the experimental Tsub(e) profiles typically leads to hollow current profiles and that the disruptions appear to be related to the local minimum of q inside

the plasma attaining near-integral values. Disruptions may be avoided by decreasing the rate of current rise. This leads to improved plasma conditions throughout the discharge.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 26699

26702 Mode conversion of lower-hybrid waves. Chan, V.S.; Chiu, S.C.; Guest, G.E. (General Atomic Company, San Diego, California 92138). EY-76-C-03-0167, PROJ. AGREEMENT NO. 38. *Phys. Fluids;* **23**: No. 6, 1250-1253(Jun 1980).

In an inhomogeneous plasma, partial conversion of lower-hybrid waves to ion plasma waves can occur for a range of plasma parameters, even in the absence of a reflection layer. Nonetheless, mode conversion may be significantly reduced if the plasma is sufficiently dissipative. If electron Landau damping is a dominant dissipation mechanism, the quasi-linear behavior of the electron distribution function can introduce a strong rf power dependence into the mode conversion efficiency. At low rf power levels the damping may be too large to permit effective mode conversion, while above some critical power level, the quasi-linear flattening of the distribution function may sufficiently reduce the damping to permit strong mode conversion.

26703 Decay of a lower-hybrid wave to two lower-hybrid waves. Reiman, A. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). ET78-S-02-4682. *Phys. Fluids;* **23**: No. 6, 1254-1262(Jun 1980).

The threshold and initial evolution for the decay of a lower-hybrid wave to two lower-hybrid waves are determined. Included are the effects of convective losses in a three-dimensional lower-hybrid resonance cone geometry and the effects of inhomogeneity appropriate to lower-hybrid heating in a tokamak. It is found that the decay to two lower-hybrid waves differs from other such parametric instabilities previously studied in that its instability threshold can have a strong dependence on the minor radius of the tokamak. This is due to the quasi-absolute nature of the instability. While its threshold power is high in small devices, the instability poses a serious threat in reactor size devices.

26704 Nonlinear estimates of Brillouin scatter in plasma. Kruer, W.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *Phys. Fluids;* **23**: No. 6, 1273-1275(Jun 1980).

Simple models are used to provide nonlinear estimates of Brillouin scatter in several complementary regimes. Some applications to laser plasma interactions are given.

26705 Observation of anomalous penetration of rf fields in a collisionless plasma. Goede, H.; Dawson, J.M.; MacKenzie, K.R. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024). EY-76-C-03-0010. *Phys. Rev. Lett.;* **44**: No. 16, 1066-1068(21 Apr 1980).

The radial penetration of low-frequency (ω very-much-less-than ω/sub p/e) electromagnetic fields is measured in cylindrical geometry. Classical skin depths (c/ω/sub p/e) are observed until the wave frequency is low enough for electron thermal effects to result in enhanced wave penetration.

26706 Stability of solitary kinetic Alfven waves. Sheerin, J.P. (Michigan Univ., Ann Arbor (USA). Dept. of Physics); Ong, R.S.B. (Michigan Univ., Ann Arbor (USA)). *Phys. Lett., A;* **73**: No. 5-6, 389-390(15 Oct 1979).

The stability of the solitary kinetic Alfven wave is investigated. In the one-dimensional fully nonlinear case the wave is shown to be stable against perturbations in the amplitudes.

FUSION POWER PLANT TECHNOLOGY

26707 (DOE/TIC—11189) ORNL tokamak program FY 80 to FY 85 for DOE-ETM. Murakami, M.; Langley, R.A.; Saltmarsh, M.J.; Sheffield, J. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 32p. NTIS, PC A03/MF A01.

A comparison of predicted and actual progress during the period Sept. 78 to Aug. 1979 is made. A schedule for FY 81, 82, 83, 84, and 85 is given. (MOW)

26708 (EPRI-AP—1347) Fusion experimental power reactor (EPR) design tasks. Prater, R.; Stambaugh, R.; Wesley, J.; Bhadra, D.; Matsuda, K.; Rovner, L. (General Atomic Co., San Diego, CA (USA)). Feb 1980. 475p. NTIS, PC A20/MF A01.

Several key physics and technology problem areas which were identified in the previous Experimental Power Reactor study were investigated. These were plasma confinement, plasma heating, reactor refueling, and reactor first wall regeneration. The plasma confinement experimental studies showed no instabilities or enhanced transport in the trapped ion regime. The RF heating experiments indicated that RF could produce highly efficient plasma heating. Two reactor refueling schemes was considered in a theoretical analysis: the first was the convective transport from the cold plasma blanket to the plasma interior and the second was the use of high speed frozen pellets to carry the fuel to the plasma interior. Both schemes were shown to be feasible. Finally, the in-situ replacement of first walls using atomic coating processes was considered. The vapor deposition of carbon was shown to be promising.

26709 Is there a role for fusion. Rose, D.J. (Massachusetts Inst. of Tech., Cambridge). pp 355-360 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

The possible development of fusion as a viable energy source is reviewed. The timetables involved for commercial fusion are discussed. Finally, some economic perspectives are outlined. (MOW)

26710 Prospects of toroidal magnetic fusion. Ohkawa, T. (General Atomic Co., San Diego, CA). pp 373-385 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

The basics of tokamak operation are described. MHD instabilities, plasma diagnostic techniques, heating techniques, and scaling laws are discussed in particular. (MOW)

26711 Economic impact of a laser fusion breeder on the US energy economy. Goldman, L.M. (Univ. of Rochester, NY). pp 481-492 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

One of the most likely uses of a fusion reactor is a breeder of fissile fuel for fission reactors. This study examines the possible impact that the availability of a fusion breeder would have on the total energy economy of the United States over the next sixty years. The principal conclusion is that a successful fusion breeder would have a very significant impact on the value of fission fuel and, therefore, the cost of electricity. (MOW)

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 26141

26712 (BNL—27755) Fusion blankets for high efficiency power cycles. Powell, J.R.; Fillo, J.A.; Horn, F.L.; Lazareth, O.W.; Usher, J.L. (Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract AC02-76CH00016. 77p. NTIS, PC A05/MF A01.

Definitions are given of 10 generic blanket types and the specific blanket chosen to be analyzed in detail from each of the 10 types. Dimensions, compositions, energy depositions and breeding ratios (where applicable) are presented for each of the 10 designs. Ultimately, based largely on neutronics and thermal hyraulics results, breeding an nonbreeding blanket options are selected for further design analysis and integration with a suitable power conversion subsystem.

26713 Dynamic loading of the structural wall in a lithium-fall fusion reactor. Glenn, L.A.; Young, D.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Eng. Des.;* **54**: No. 1, 1-16(Sep 1979).

The authors formulated a simple model of a lithium-fall ICF reactor and calculated the fall disassembly and the subsequent fluid-wall interaction resulting from the energy deposition by a laser-imploded fusion pellet. Two potential mechanisms for wall damage were identified: surface erosion and hoop failure. For single fall designs, the erosion problem appears to be serious. Concentric annuli (multiple fall) or packed jet configurations may be feasible but experiments are needed to clarify the physical model.

26714 Design techniques for ceramics in fusion reactors. Trantina, G.G. (General Electric Co., Schenectady, NY (USA)). *Nucl. Eng. Des.;* **54**: No. 1, 67-77(Sep 1979).

Unique design techniques are needed for low activity ceramic materials in first wall/blanket regions of fusion reactors. A Weibull probabilistic design approach is used to characterize the scatter in the fracture strength and the size effect. Results indicate that ceramic first wall/blanket structures should be modular and each module should be proof tested. The ceramic materials should have high fracture strength, high Weibull modulus, and minimal strength degradation due to subcritical crack growth. The Weibull statistical

analysis is coupled with finite element thermal and stress analysis and the probability of failure of ceramic first wall/blanket design concepts is predicted. The usefulness of the approach is demonstrated by optimizing the geometry of the structure to produce minimum probability of failure.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 26155, 26694, 26738

26715 (CONF-800631—4) **Pressure rise during the quench of a superconducting magnet using internally cooled conductors.** Miller, J.R.; Dresner, L.; Lue, J.W.; Shen, S.S.; Yeh, H.T. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-48. 9p. NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

Superconducting magnets cooled by supercritical helium flowing through internal conductor passages are an alternative to magnets cooled in a boiling pool. This alternative involves a possible large pressure increase in the captured volume of helium during a quench. In the US Large Coil Program (LCP), three of six coils to be tested will use internally cooled conductors. This paper describes experiments performed to understand the quench behavior of the Westinghouse coil. Agreement between experiment and theory is good. Also discussed is the extension of this work to the EURATOM coil and the Swiss coil, as well as to any coils wound with internally cooled conductors.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 26714

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 26676

26716 (UCID—18587) **Practical aspects of rf acceleration for MFE injection.** Hamilton, G.W.; Fink, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Jun 1980. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01.

Several practical aspects of rf acceleration (by a MEQALAC accelerator, for example) of positive and negative ions for MFE neutral injection were considered. The beam transport, gas flow, differential pumping, and compatibility with MFE beam lines were examined. It was found that rf acceleration has several advantages over dc acceleration, especially if high energy (over 100 keV) and/or high purity (over 99%) is required. Therefore rf acceleration should be considered especially in connection with negative ions, which also have competitive advantages under such requirements. Beam densities for rf may be lower than dc beam densities because of space charge limitations and electrode transparency. However, the overall dimensions of an rf system are competitive with or smaller than the dimensions of a dc system of equal current and voltage because the gas pumping and electrical insulation are included within the rf electrode assembly. Ion source development is required to produce an array of many small beams suitable for injection into a MEQALAC.

26717 **Intense 3 ns neutron source.** Chang, J.; Leeper, R.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *Rev. Sci. Instrum.;* **51**: No. 6, 715-720(Jun 1980).

A 3 ns pulsed beam-target neutron source has been developed to simulate a thermonuclear neutron burst from an inertial confinement fusion target. The yield from the neutron source is equivalent to an isotropic source producing $\sim 3 \times 10^6$ D—D and $\sim 2 \times 10^7$ D—T neutrons into 4 π steradians per pulse. The unique features of this source include simplicity of design, ease of operation, multiple shot capability, and above all compactness which permits easy portability and in situ applications. The use of these sources for characterizing the impulse response of heavily shielded scintillation neutron time-of-flight detectors operating in the mean-level detection mode is discussed.

26718 **Tritium and fissile fuel exchange between hybrids, fission power reactors, and tritium production reactors.** Youssef, M.Z.; Conn, R.W.; Vogelsang, W.F. (Univ. of Wisconsin, Madison). *Nucl. Technol.;* **47**: No. 3, 397-405(Mar 1980).

A mathematical model extending work by Gordon and Harms is developed to describe the fissile fuel and tritium flows in a fusion-fission system consisting of a fusion hybrid reactor, a tritium production reactor, and several fission power reactors. The hybrid reactor plays the role of a fuel factory, providing the fission reactors and the tritium production reactor with their fissile fuel needs. The tritium production reactor (a fission reactor) is devoted primarily to producing tritium for subsequent use in the hybrid. Different combinations of these systems are found by shifting the tritium breeding function among the various parts. At steady state, the total thermal power in fission reactors per unit of fusion power depends only on the total conversion ratio of the fission reactors and the hybrid. An economic analysis is required to determine which combination of systems will produce electricity at the lowest costs.

26719 **Shielding calculations for the Tokamak Fusion Test Reactor neutral beam injectors.** Santoro, R.T.; Lillie, R.A.; Alsmiller, R.G. Jr.; Barnes, J.M. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **47**: No. 3, 412-420(Mar 1980).

Two-dimensional discrete-ordinates calculations have been performed to determine the location and thickness of concrete shielding around the Tokamak Fusion Test Reactor neutral beam injectors. Two sets of calculations were performed, one to determine the dose equivalent rate on the roof and wall of the test cell building when no injectors are present, and one to determine the contribution to the dose equivalent rate at these locations from radiation streaming through the injection duct. Shielding the side and rear of the neutral beam injector with 0.305 and 0.61 m of concrete, respectively, and lining the inside of the test cell wall with an additional layer of concrete having a thickness of 0.305 m and a height above the axis of deuteron injection of 3.10 m is sufficient to maintain the biological dose equivalent rate outside the test cell to $\sim$ 1 mrem/D-T pulse.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

REFER ALSO TO CITATION(S) 26727

26720 (ANL—79-82) **TSOAK-M1: a computer code to determine tritium reaction/adsorption/release parameters from experimental results of air-detritiation tests.** Land, R.H.; Maroni, V.A.; Minkoff, M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 40p. Dep. NTIS, PC A03/MF A01.

A computer code has been developed which permits the determination of tritium reaction (T_2 to HTO)/adsorption/release and instrument correction parameters from enclosure (building) - detritiation test data. The code is based on a simplified model which treats each parameter as a normalized time-independent constant throughout the data-unfolding steps. Because of the complicated four-dimensional mathematical surface generated by the resulting differential equation system, occasional local-minima effects are observed, but these effects can be overcome in most instances by selecting a series of trial guesses for the initial parameter values and observing the reproducibility of final parameter values for cases where the best overall fit to experimental data is achieved. The code was then used to analyze existing small-cubicle test data with good success, and the resulting normalized parameters were employed to evaluate hypothetical reactor-building detritiation scenarios. It was concluded from the latter evaluation that the complications associated with moisture formation, adsorption, and release, particularly in terms of extended cleanup times, may not be as great as was previously thought. It is recommended that the validity of the TSOAK-M1 model be tested using data from detritiation tests conducted on large experimental enclosures (5 to 10 cm^3) and, if possible, actual facility buildings.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 26170, 26660

26721 **Microradiographic microsphere manipulator.** Singleton, R.M. US Patent Application 005,948. [nd]. 9p.

A method and apparatus is disclosed for radiographic characterization of small hollow spherical members (microspheres), constructed of either optically transparent or opaque materials. The apparatus involves a microsphere manipulator which holds a batch of microspheres between two parallel thin plastic films for contact microradiographic characterization or projection microradiography thereof. One plastic film is translated relative to and parallel to the other to roll the microspheres through any desired angle to allow different views of the microspheres.

26722 (CONF-800723—8) **Heat transfer in inertial confinement fusion reactor systems.** Hovingh, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Apr 1980. Contract W-7405-ENG-48. 23p. NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

The short time and deposition distance for the energy from inertial fusion products results in local peak power densities on the order of 10^{18} watts/m^3. This paper presents an overview of the various inertial fusion reactor designs which attempt to reduce these peak power intensities and describes the heat transfer considerations for each design.

26723 (SAND—80-0696C) **Pulsed power technology for particle beam fusion.** VanDevender, J.P.; Martin, T.H.; Johnson, D.L.; Neau, E.L.; Crow, J.T.; Yonas, G. (Sandia Labs., Albuquerque, NM

(USA)). 1980. Contract AC04-76DP00789. 14p. (CONF-800555—1). NTIS, PC A02/MF A01.

From International conference on lasers; Shanghai, China (3 May 1980).

A brief review of the PBFA I is given and some of its advantages for inertial confinement fusion are described. (MOW)

26724 Effect of flux-limited thermal conduction on the jump conditions of the laser-plasma critical surface. Mayer, F.J.; Berger, R.L.; Max, C.E. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). ED-78-C-08-1598;W-7405-ENG-48. *Phys. Fluids;* **23**: No. 6, 1244-1249(Jun 1980).

The effects of flow, radiation pressure, and flux-limited thermal conduction on the plasma profile near the critical surface are examined. When the absorbed flux is deposited locally and the thermal conduction is inhibited, the density profile and plasma flow are determined by the flux limit because the self-consistent plasma pressure is larger than the radiation pressure.

26725 Neutron moderation in inertial confinement fusion pellets and effects on damage and radioactive inventory. Beranek, F.; Conn, R.W. (Univ. of Wisconsin, Madison). *Nucl. Technol.;* **47**: No. 3, 406-411(Mar 1980).

A standard time-dependent neutron transport computer code, TDA, is modified to allow time-varying material density to calculate the neutron spectrum from exploding inertial confinement fusion pellets with rho R values of 0 to 6 g/cm². Softening of the spectra due to neutron-fuel interactions causes a time-of-flight broadening of the neutron arrival time distribution at the chamber wall. It is found that the total number of displacements per atom (dpa) produced in a graphite first wall increases with the rho R of the pellet over the rho R range investigated because the dpa cross section is larger at lower neutron energy. However, the total helium production decreases with increasing rho R, as does the peak damage rate. Neutron-induced radioactivity generated in a 10-mg iron tamper is of the same magnitude as that produced in the rest of an entire reactor system.

26726 Influence of high-energy ion loss on DT reaction rate in laser fusion pellets. Petschek, A.G.; Henderson, D.B. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Fusion;* **19**: No. 12, 1678-1680(Dec 1979).

Because of the longer mean free path of high-energy ions, they will be preferentially lost from small pellets containing thermonuclear reactants. This effect has been calculated and, in the most extreme case calculated, a factor-of-about-four reduction of the reaction rate in DT from the Maxwell average rate at the same mean ion kinetic energy is found.

26727 Some safety considerations in laser-controlled thermonuclear reactors. Ullman, A.Z.; Botts, T.E.; Breton, D.; Chan, C.K.; Sehnert, M.; Kastenberg, W.E.; Okrent, D. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). *Nucl. Eng. Des.;* **53**: No. 3, 301-319(Aug 1979).

The potential safety problems which might be encountered in laser-driven controlled thermonuclear reactors (LCTR) have been examined and compared with previous studies of magnetically-confined systems. In several significant ways, including tritium hazards and some blanket cooling functions, laser-driven systems appear to differ only in quantitative ways from magnetic systems. Several aspects of safety of laser-driven systems are distinctive to them. These include cooling means designed to handle the pulsetile energy deposition from pellet explosions, and various equipment and containment penetrations associated with the lasers. Specific safety analyses have been performed for a loss-of-flow accident (LOFA) in a wetted-wall LCTR, and failure modes for laser penetrations are considered in detail to ascertain appropriate component placement and design criteria.

26728 Development of inertial confinement fusion, the inexhaustible energy source. Gomberg, H.J. (KMS Fusion Inc., Ann Arbor, MI). pp 413-448 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

A status report on laser fusion research at KMS Fusion is given. Future directions of the program are also discussed. (MOW)

26729 Potentialities of CO_2 lasers for inertial fusion. Perkins, R.B. (Los Alamos Scientific Lab., NM). pp 449-467 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

A review of the Los Alamos research program on Co_2 lasers is given. The suitability of the CO_2 laser for inertial confinement fusion is described. Some recent experimental results and reactor conceptual design studies are discussed. (MOW)

26730 Laser fusion as a power reactor concept. Conn, R.W. (Univ. of Wisconsin, Madison). pp 469-479 of Nuclear energy and alternatives. Kadiroglu, O.K.; Perlmutter, A.; Scott, L. (eds.). Cambridge, MA; Ballinger Publishing Company (1978).

From International scientific forum on an acceptable nuclear energy future of the world; Fort Lauderdale, FL, USA (7 Nov 1977).

This study is a self-consistent examination of problems, both in physics and technology, likely to be important to the future development of the laser fusion approach to power generation. (MOW)

26731 Delta amplifier (14 May 1978) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2654).

38 drawings.

The delta amplifier is the booster amplifier of the Shiva system. It has a clear aperature of 20.5 cm and a small signal gain of 2.10 at 24 kV. These are the laser disks at Brewsters angle with 32 close packed flashlamps surrounding them. Between the lamps and the disks is a quartz tube which separates the pump cavity from the lamp cavity. A case, split in quadrants, surrounds the entire assembly and serves as a structural spine and hermetic seal. Particular emphasis has been given to cleanliness to avoid beam obscurations, control of parasitic oscillations, high optical gain, and well engineered machined elements.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 26103, 26104, 26105, 26106, 26107, 26109, 26110, 26111, 26112, 26113, 26114, 26122, 26141, 26154, 26155, 26159, 26160, 26161, 26162, 26163, 26164, 26165

26732 (ANL/FPP/TM—126) Materials program plan for inertial confinement fusion. Garde, A.; Hall, B.O.; Harkness, S.D.; Maiya, P.S.; Rechtin, M.D.; Li, C.Y. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 87p. NTIS, PC A05/MF A01.

The effect of the irradiation environment on the microstructure of materials is studied. A major part of the initial activity in this area will be aimed toward evaluating the importance of pulse effects on microstructural development. The development effort that is necessary to cope with the high cycle loading of the first wall structure is studied. The loading pulses are expected to range from 1 to 20 per second (3×10^7 to 6×10^8/year), thus creating a high cycle fatigue problem for any long-lived first wall structure. The interrelationship between specimen and component testing is a major issue in this section. Static mechanical property requirements are also considered here. Lithium compatibility is treated. The final section integrates the conclusions reached in the body of the report into a unified strategy that suggests a particular effort level to support major program milestones.

26733 (CONF-800607—56) Design of materials irradiation experiments utilizing spectral tailoring. Gabriel, T.A.; Lillie, R.A.; Bishop, B.L. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The helium production to displacement per atom (He/DPA) ratio expected at the first wall of a fusion reactor for stainless steel alloys can be, within reasonable limits, reproduced in real time in fission reactors such as the Oak Ridge Research Reactor (ORR) due to the helium production characteristics of Ni(^{58}Ni + n/sub th/ → ^{59}Ni + n/sub th/ → ^{56}Fe + α). The reproduction of the He/DPA ratio can be accomplished by intermittent modification of the thermal-to-fast neutron flux ratio since the He production will be dominated by the thermal fluence and the fast fluence will determine the DPA. This report summarizes some of the neutronic calculations that are being carried out to determine the amount of change as a function of time necessary in the thermal-to-fast ratio and the design of the experimental capsules that will produce the needed changes.

26734 (DOE/ET/52048—1) Minerals resource implications of a tokamak fusion reactor economy. Cameron, E.; Conn, R.W.; Kulcinski, G.L.; Sviatoslavsky, I. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). Sep 1979. Contract AC02-78ET52048. 73p. (UWFDM—313). NTIS, PC A04/MF A01.

The mineral resource implications of an economy of tokamak-type fusion reactors are assessed based upon the recent conceptual reactor design study, NUWMAK, developed at the University of Wisconsin. For comparative purposes, various structural alloys of vanadium and steel are assumed to be usable in the NUWMAK design in place of the titanium alloy originally selected. In addition, the inner blanket core and magnet system of the conceptual reactor, HFCTR, developed at the Massachusetts Institute of Technology,

are assumed to be interchangeable with the comparable components in NUWMAK. These variations permit a range of likely requirements to be assessed.

26735 (HEDL-SA—1918-FP) **FMIT Facility and lithium system design.** Trego, A.L.; Miller, W.C. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1980. Contract AC14-76FF02170. 10p. (CONF-800401—11). NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

The Fusion Materials Irradiation Test Facility (FMIT) will provide a high-flux, high-energy neutron source that will produce bulk irradiation damage in material specimens similar to that expected in a fusion reactor first wall. The neutrons will be generated using a deuteron-lithium stripping reaction by impinging a deuteron beam from a linear accelerator on a flowing lithium target. The FMIT is described together with the Lithium System and its unique features.

26736 (NBSIR—80-1627) **Materials studies for magnetic fusion energy applications at low temperatures. III.** Reed, R.P. (ed.). (National Bureau of Standards, Boulder, CO (USA). Fracture and Deformation Div.). Jun 1980. Contract EA-77-A-01-6010-024. 396p. NTIS, PC A17/MF A01.

The reports presented here summarize the work of the low temperature materials research project for the third year of the program. The various projects are outlined and the research results are presented. The major thrust of the measurements has been the evaluation of the low temperature mechanical and physical properties of stainless steel base metal and welds, with particular emphasis on the nitrogen-strengthened stainless steels. Aluminum alloys have received some consideration also. Work has also been done on the production and standardization of nonmetallics, primarily indusrial laminates, for low temperature applications and on the measurement of their properties at cryogenic temperatures. Separate abstracts were prepared for each paper. (MOW)

26737 (UCRL—50058-80-1) **Advances in materials science, Metals and Ceramics Division. Triannual progress report, October 1979-January 1980.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Mar 1980. Contract W-7405-ENG-48. 42p. NTIS, PC A03/MF A01.

Progress is summarized concerning magnetic fusion energy materials, laser fusion energy, aluminium-air battery and vehicle, geothermal research, oil-shale research, nuclear waste management, office of basic energy sciences research, and materials research notes. (FS)

26738 (UCRL—83916) **Superconductivity and cryogenics for mirror fusion.** Cornish, D.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 May 1980. Contract W-7405-ENG-48. 22p. (CONF-800631—5). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

A brief introduction to the mainline experiments being presently pursued in mirror fusion research is followed by a more detailed description of the cryogenic and superconductive aspects of the Mirror Fusion Test Facility (MFTF) and its extension to a tandem machine. The large volume of magnetic field required for confinement has a maximum intensity of close to 8 T and is produced by a variety of superconducting magnets. A large and complex cryogenic system is necessary to provide the 4-K environment for these coils and to meet the large cryopumping needs of the machine.

26739 (UWFDM—313) **Minerals resource implications of a tokamak fusion reactor economy.** Cameron, E.; Conn, R.W.; Kulcinski, G.L.; Sviatoslavsky, I. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). Sep 1979. Contract EY-76-S-02-2272. 13p. NTIS, PC A04/MF A01.

The mineral resource implications of an economy of tokamak-type fusion reactors are assessed based upon the recent conceptual reactor design study, NUWMAK, developed at the University of Wisconsin. For comparative purposes, various structural alloys of vanadium and steel are assumed to be usable in the NUWMAK design in place of the titanium alloy originally selected. In addition, the inner blanket core and magnet system of the conceptual reactor, HFCTR, developed at the Massachusetts Institute of Technology, are assumed to be interchangeable with the comparable components in NUWMAK. These variations permit a range of likely requirements to be assessed.

26740 **Effects of Fe-Ni-Co-V structural alloys on fusion reactor neutronic performance.** Barnes, J.M.; Bishop, B.L.; Santoro, R.T.; Gabriel, T.A. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **47**: No. 3, 496-498(Mar 1980).

Calculations have been carried out to determine the effect of Fe-Ni-Co-V alloys on fusion reactor neutronic performance. The radiation damage in the first structural wall and the tritium breeding ratio were calculated as a function of alloy composition using the tritium breeding blanket module of the Experimental Power Reactor as the reference design. The atomic displacement rate was found to be approximately constant for all alloy combinations. However, the gas production and tritium breeding exhibit reasonably large variations (~ 20%) as the cobalt concentration is increased in the alloy.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 25975

26741 (DOE/CR/10001—T1) **Department of Energy Audit Report Tracking System (DARTS). Quarterly Management Report as of December 31, 1979.** (Computer Sciences Corp., Falls Church, VA (USA)). 1979. Contract AC01-79CR10001. 75p. NTIS, PC A04/MF A01.

This report provides information on the status of corrective actions on audit recommendations contained in audits of DOE activities, programs, and contracts. It is based on data and information reported to the Controller by DOE Headquarters elements and field offices in accordance with draft DOE Order 2300, Audit Compliance and Follow-Up. The report covers an update of matters reviewed at the initial meeting of the DOE Audit Review Council, the basic provisions of the proposed final order on audit compliance and follow-up, an assessment of progress under the DARTS to date, listings of the open General Accounting Office and Inspector General audit and inspection reports, and statistical data in summary form and in detail for DOE Headquarters and each reporting field office. 2 figures, 48 tables. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 25241, 25904, 26633

26742 (ANL/AMD/TM—348) **ILN RJE user's guide for TI990/TX990 hosts.** Henderson, L.; Lidinsky, W.; Weddige, R.; Zelle, B. (Argonne National Lab., IL (USA)). 31 Mar 1980. Contract W-31-109-ENG-38. 25p. NTIS, PC A02/MF A01.

The Intra-Laboratory Network (ILN) is a general-purpose computer communications network located at Argonne National Laboratory. This network provides communications between computers connected to the network. In addition to its general-purpose capability, the ILN also provides a remote job entry (RJE) system that allows users to move files from the user's computer system to ANL's Central Computing Facility (CCF), move files from the CCF to the user's computer system as batch job retrievals, check on the status of CCF jobs, cancel jobs, etc. This document describes the use of the ILN RJE system for users who have TI990 computer systems running the TX990/TXDS operating system. The ILN RJE system consists of three parts. Closest to the user is the ILN RJE utility program that runs on the user's host. Between the host and the CCF is the ILN which contains, in addition to the network control, an ILN RJE facility that supports the utility program and interfaces to the CCF. The third part is the CCF, which is accessed via the CCF front-end Varian V73 communications processors. The procedures for running the ILN RJE utility program are described first. Next, the commands that can be used to submit and retrieve jobs, check on job status, etc., are discussed. Each command description includes the command syntax, a brief description of the function, and one or more examples. Then techniques for transferring files between a host and either CCF or another host are outlined. Appendixes summarize the ILN RJE system commands, the possible error messages and the ASCII/EBCDIC conversion table that is used in the ILN. (RWR)

26743 (ANL/AMD/TM—349) **ILN RJE user's guide for PDP-11/RSX-11M hosts.** Henderson, L.; Lidinsky, W.; Meyer, C.; Rynes, P.; Weddige, R.;Zelle, B. (Argonne National Lab., IL (USA)). 31 Mar 1980. Contract W-31-109-ENG-38. 27p. NTIS, PC A03/MF A01.

The Intra-Laboratory Network (ILN) is a general-purpose computer communications network located at Argonne National Laboratory. This network provides communications between computers connected to the network. In addition to its general-purpose capability, the ILN also provides a remote job entry (RJE) system that allows users to move files from the user's computer system to ANL's Central Computing Facility (CCF), move files from the CCF to the user's computer system, and check on the status of CCF jobs, cancel jobs, etc. This document describes the use of the ILN RJF system for users who have DEC PDP-11 computer systems running the RSX-11M operating system. The ILN RJE system consists of three parts. Closest to the user is the ILN RJE utility program that runs on the user's host. Between the host and the CCF is the ILN

which contains, in addition to the network control, an ILN RJE facility that supports the utility program and interfaces to the CCF. The third part is the CCF, which is accessed via the CCF front-end Varian V73 communications processors. The procedures for running the ILN RJE utility program are described first. Next, the commands that can be used to submit and retrieve jobs, check on job status, etc., are discussed. Each command description includes the command syntax, a brief description of the function, and one or more examples. Then several techniques for transferring files between a host and either CCF or another host are outlined. Appendixes summarize the ILN RJE system commands, the possible error messages, and the ASCII/EBCDIC conversion table that is used in the ILN.

26744 (COO—4596-1) **Radian remote sampling system digital processor system. Software detail documentation: Pittsburgh Energy Research Center.** (Radian Corp., Austin, TX (USA)). 1 Nov 1979. Contract EY-77-C-02-4596. 93p. NTIS, PC A05/MF A01.

Software documentation for the DART data acquisition system is provided. This system runs on a minicomputer. After an overview of the system and file structures, the various subprograms are discussed individually; flow charts are included. 37 figures. (RWR)

26745 (DOE/EIA/10597—T1) **Development of software for computer assisted model simplification. Final report.** (DBS Corp., Arlington, VA (USA)). 25 Apr 1980. Contract AC01-79EI-10597. 48p. Dep. NTIS, PC A03/MF A01.

The final report of DBS Corporation on the model simplification project is presented. The purpose of the project is to develop computer-assisted model simplification. The contributions of DBS to this project where an initial overall project assessment, contributions to design principles and testing procedures, specific experimental designs, and initial test results. The main contributions of DBS to this project were in the area of LP matrix scaling, and particularly in the potential usefulness of shadow price information for model simplification. An algorithm for obtaining approximate shadow price information was developed and subjected to initial small-scale testing with promising results.

26746 (ORNL/TM—6933) **User's manual for TEDPED, an interactive code for testing the hypothesis of log-normally or normally distributed data.** Fields, D.E.; Little, C.A.; Shaeffer, D.L. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 69p. NTIS, PC A04/MF A01.

TEDPED is an interactive computer code that produces both graphical and numerical descriptions of a set of data based on the user's assumption of either a normal or a log-normal distribution. Numerical statistics calculated by TEDPED at the user's option are the chi-square, Kolmogorov-Smirnov, and Pearson's. The linearized cumulative-probability distribution of the data may be plotted, together with a least-squares fit, consistent with either the normal or log-normal assumption. Data input may be by named data file or via the user's terminal keyboard. The code is written in FORTRAN and runs on a Digital Equipment Corporation PDP-10 computer; typical central-processor-unit execution time is about 0.32 s. 50 figures, 1 table.

26747 (SAND—79-0877) **Defining solid objects. Comparing wire frame with constructive solid geometry representations.** Peterson, D.P. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 22p. NTIS, PC A02/MF A01.

The modelers of geometric objects measure their success by studying voluminous computer listings or, preferably, graphical output. Making this measurement even more difficult is that the modeler must determine what is an appropriate response for the computer to make in every conceivable situation; just as surely as a false premise negates the most careful reasoning, the modeler will find that any inconsistency in formulating this model will result in an inconsistency in its description of reality. Therefore, the first task that the modeler must address himself to is answering the question, What is a solid object?

26748 (SAND—79-2147) **VGRAF: a color plot program for producing professional-quality slides, viewgraphs, posters, and data plots.** Padilla, G.C.; Thompson, S.L. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 114p. NTIS, PC A06/MF A01.

VGRAF is a powerful FORTRAN computer program designed to produce professional-quality color slides, viewgraphs, posters, and data plots for presentations or reports. The program is easy to use and requires no a priori knowledge of a programing language and little or no previous programing experience. The use of the VGRAF program and its commands are described. Many examples of VGRAF-produced plots are included. 10 figures, 2 tables.

26749 (SAND—79-2376) **IDES: Interactive Data Entry System: a generalized data acquisition software package.** Gasser, S.B. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 94p. NTIS, PC A05/MF A01.

The Interactive Data Entry System (IDES) is a software package which greatly assists in designing and storing forms to be used for the directed acquisition of data. Objective of this package is to provide a viable man/machine interface to any comprehensive data base. This report provides a technical description of the software and can be used as a user's manual.

26750 (UCID—18543) **Graphics library for real time display and data analysis.** Brand, H.R.; Yamauchi, R.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jan 1980. Contract W-7405-ENG-48. 169p. NTIS, PC A08/MF A01.

A graphics library was written to plot chemical experimental data in real time and to plot data analysis results interactively. The library is designed for use on Digital Equipment Corporation's (DEC) RSX-11M operating system. The graphics devices are a 17-inch cathode ray tube (CRT) with light pen, a Tektronix 4025 terminal, and a four-pen plotter. 4 figures.

26751 **Practical use of high-order methods for hyperbolic systems.** Turkel, E. (Courant Institute of Mathematical Sciences, New York University, New York 10012). EY-76-C-02-3077. *J. Comput. Phys.;* **35**: No. 2, 319-340(May 1980).

A number of high-order methods are tested on a variety of dynamic problems in one, two, and three space dimensions. These problems include wave propagation phenomena as well as an asymptotic approach to a steady state. Both smooth and shocked flows are considered. The methods compared require only minor modifications of many existing second-order schemes. The results show that significant gains can be expected from the used of fourth-order methods. Spectral methods are also considered for some of the problems presented.

26752 **Bounds on solutions of linear systems with inaccurate data.** Cope, J.E.; Rust, B.W. (Union Carbide Corp., Oak Ridge, TN). *SIAM J. Numer. Anal.;* **16**: No. 6, 950-963(Dec 1979).

Previous work has dealt with the problem of finding the solution set of a system of m equations in n unknowns, $Ax = b$, where A and b are known only to some limited tolerance, $A^0 - \Delta A \leqq A \leqq A^0 + \Delta A, b^0 - \Delta b \leqq b \leqq b^0 + \Delta b$ with ΔA and Δb being arrays consisting of positive elements. For a given n-vector x, necessary and sufficient conditions have been established for x to be an exact solution for some system anti Ax = anti b, where $A^0 - \Delta A \leqq$ anti $A \leqq A^0 + \Delta A$ and $b^0 \leftarrow - \Delta A$ and $b^0 - \Delta b \leqq$ anti $b \leqq b^0 + \Delta b$. These results are extended and the emphasis is changed. If the orthant in which the true solution vector x lies is known from some a priori consideration, and if A and b are as above, it is possible to compute bounds for x by linear programing. The tableau for the problem is developed. The results are extended to finding confidence intervals for x in the case where A and b are random samples from distributions with known variances. A discussion of the application of the technique to solving first-kind Fredholm equations is also given. The technique is applied to three example problems. 4 figures.

26753 **Penalty correction method for elliptic boundary value problems.** Pasciak, J. (Brookhaven National Lab., Upton, NY). *SIAM J. Numer. Anal.;* **16**: No. 6, 1046-1059(Dec 1979).

A new finite element method is introduced for approximating elliptic boundary value problems with inhomogeneous Dirichlet boundary conditions. This new method, the penalty correction method, leads to approximations that are optimal in H^1, L^2, and negative Sobolev spaces without very stringent assumptions on the approximating subspaces, viz., the subspaces need not satisfy the Dirichlet boundary conditions or inverse properties. Computationally, the method involves solving the same matrix system, corresponding to Babuska's penalty method, for a number of input vectors. Thus, one can take full advantage of matrix decomposition algorithms available. The penalty correction method also gives rise to high-order approximations to the normal derivative of the solution at the boundary without computing normal derivatives.

26754 **Extrapolation method of order four for linear sequences.** King, R.F. (Argonne National Lab., IL). *SIAM J. Numer. Anal.;* **16**: No. 5, 719-725(Oct 1979).

The Aitken δ^2 process produces second-order convergence for sequences that would otherwise converge just linearly. It requires two substeps for each extrapolation step, and hence has an efficiency of $\sqrt{2}$. In the method discussed here, fourth-order convergence is attained in but three substeps, for an improved efficiency of 4/sup 1/3/ = 1.587. The examples tabulated are for Newton's method applied to finding a multiple root of a nonlinear equation. 2 tables.

26755 **Relationship between the BFGS and conjugate gradient algorithms and its implications for new algorithms.** Nazareth, L. (Argonne National Lab., IL). *SIAM J. Numer. Anal.;* **16**: No. 5, 794-800(Oct 1979).

On the basis of analysis and numerical experience, the BFGS (Broyden-Fletcher-Goldfarb-Shanno) algorithm is currently considered to be one of the most effective algorithms for finding a minimum of an unconstrained function, f(x), x an element of R/sup n/. However, when computer storage is at a premium, the usual alternative is to use a conjugate gradient (CG) method. It is shown here that the two algorithms are related to one another in a particularly close way. Based upon these observations, a new family of algorithms is proposed. 2 tables.

26756 Galerkin method based on Hermite cubics. Hedstrom, G.W. (Univ. of California, Livermore). *SIAM J. Numer. Anal.;* **16**: No. 3, 385-392(Jun 1979).

The Galerkin method for u/sub t/ + u/sub x/ = 0 with Hermite cubic polynomials as basis functions may be viewed as a method of lines with mesh h. A Fourier analysis of this method of lines shows that the solution has two waves, one with speed 1 and another with speed -7. If the initial data are smooth, then the amplitude of the backward wave is $O(h^4)$. By filtering out the backward wave, an accuracy $O(h^6)$ can be obtained.

26757 Gegenbauer transforms via the Radon transform. Deans, S.R. (Univ. of South Florida, Tampa). *SIAM J. Math. Anal.;* **10**: No. 3, 577-585(May 1979).

Use is made of the Radon transform on even-dimensional spaces and Gegenbauer functions of the second kind to obtain a general Gegenbauer transform pair. In the two-dimensional limit the pair reduces to a Chebyshev transform pair.

26758 Invariant system description of the stochastic realization. Candy, J.V. (Univ. of California, Livermore); Bullock, T.E.; Warren, M.E. *Automatica;* **15**: 493-495(1979).

It is shown that the class of all realizations possessing the same power spectral density can be uniquely characterized by giving an invariant system description. A new transformation group is introduced and shown to leave the spectral density unchanged. The action of this group must be considered when one is attempting to specify a stochastic realization from spectral densities or equivalently covariance sequences.

26759 Partitions into chains of a class of partially ordered sets. Metropolis, N.; Rota, G.C.; Strehl, V.; White, N. (Los Alamos Scientific Lab., NM). Contract W-7405-ENG-36. *Proc. Am. Math. Soc.;* **71**: No. 2, 193-196(Sep 1978).

Let a cube of side k in R/sup n/ be dissected into k/sup n/ unit cubes. The collection of all affine subspaces of R/sup n/ determined by the faces of the unit cubes forms a lattice L(n,k) when ordered by inclusion. A Dilworth partition into chains of L(n,k) is constructed explicitly.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 25875, 25996, 26343

26760 (DOE/EV/10274—4) **Feasibility study: PASS computer environment.** (American Management Systems, Inc., Arlington, VA). 10 Mar 1980. Contract AC02-79EV10274. 23p. NTIS, PC A02/MF A01.

The Policy Analysis Screening System (PASS) is a computerized information-retrieval system designed to provide analysts in the Department of Energy, Assistant Secretary for Environment, Office of Technology Impacts (DOE-ASEV-OTI) with automated access to articles, computer simulation outputs, energy-environmental statistics, and graphics. Although it is essential that PASS respond quickly to user queries, problems at the computer facility where it was originally installed seriously slowed PASS's operations. Users attempting to access the computer by telephone repeatedly encountered busy signals and, once logged on, experienced unsatisfactory delays in response to commands. Many of the problems stemmed from the system's facility manager having brought another large user onto the system shortly after PASS was implemented, thereby significantly oversubscribing the facility. Although in March 1980 Energy Information Administration (EIA) transferred operations to its own computer facility, OTI has expressed concern that any improvement in computer access time and response time may not be sufficient or permanent. Consequently, a study was undertaken to assess the current status of the system, to identify alternative computer environments, and to evaluate the feasibility of each alternative in terms of its cost and its ability to alleviate current problems.

26761 (SAND—78-1341(Rev.)(3-80)) **Abbreviations for technical writers.** Lopez, L.S. (Sandia Labs., Albuquerque, NM (USA)). Feb 1979. Contract AC04-76DP00789. 75p. NTIS, PC A04/MF A01.

A comprehensive listing of abbresivations most likely to be encountered by Sandia Laboratories (SLA) writers is presented. It was culled from Sandia technical reports, other military and Sandia listings, and commerical publications. Although the listing is informal and is meant to be descriptive rather than prescriptive, it can be considered as authoritative by SLA Technical writers. (RWR)

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Academy of Natural Sciences, Avondale, PA (USA). Stroud Water Research Center
Geographic analysis of thermal equilibria: a bioenergetic model for predicting thermal response of aquatic insect communities. Progress report, July 1, 1979-June 30, 1980, 5:26326 (DOE/EV/10259—T1)

Acurex Corp., Mountain View, CA (USA). Aerotherm Div.
Thermal response modeling of a contact-handled transuranic waste shipping container system to a fire, 5:26231 (SAND—80-0062C)

Acurex Corp., Mountain View, CA (USA). Alternate Energy Div.
Design, construction, and operation of a 150 kW solar-powered irrigation facility. Phase II. Final report, September 30, 1977-September 30, 1979, 5:25618 (ALO—4159-1)

Adelphi Univ., Garden City, NY (USA)
Coal desulfurization during the combustion of coal/oil/water emulsions: an economic alternative clean liquid fuel. Interim report, October 1978-November 15, 1979, 5:25270 (DOE/PC/10328—T1)

Aerochem Research Labs., Inc., Princeton, NJ (USA)
Experimental study of chemically reacting turbulent free shear layers. (Final report, September 23, 1976-November 30, 1978, 5:26218 (FE—2446-8)

Aerodyne Research, Inc., Bedford, MA (USA)
Characterization of open-cycle, coal-fired MHD generators. Ninth-tenth quarterly technical progress report, July 1, 1978-April 30, 1979, 5:26017 (ARI-RP—43)
Characterization of open-cycle, coal-fired MHD generators. Eleventh quarterly technical progress report, May 1-July 31, 1979, 5:26018 (ARI-RP—46)

Aeroprojects, Inc., West Chester, PA (USA)
The effect of plastic deformation on the transport of hydrogen in nickel. Tehnical report, 5:26132 (AD-A—077660/9)

Aerospace Corp., El Segundo, CA (USA). Aerophysics Lab.
Inhomogeneous broadening effects in cw chemical lasers. Interim report, 5:26233 (AD-A—077319/2)

Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.
Evaluation of line focus solar central power systems. Volume II. Systems evaluation, 5:25635 (ATR—80(7773-03)-1(Vol.2))
Evaluation of line focus solar central power systems. Volume I. Executive summary, 5:25636 (ATR—80(7773-03)-1(Vol.1))
Residential photovoltaic systems: a review and comparative evaluation of four independent studies of potential concepts, 5:25601 (SAND—80-7010)

AeroVironment, Inc., Pasadena, CA (USA)
Evaluation of hydroelastic and dynamic behavior of key components of the Ocean Turbine System. Final report, September 5, 1978-June 4, 1979. Volume I. Executive summary, 5:25469 (DOE/ET/20518—1(Vol.1))
Evaluation of hydroelastic and dynamic behavior of key components of the Ocean Turbine System. Final report, September 5, 1978-June 4, 1979. Volume II, 5:25470 (DOE/ET/20518—1(Vol.2))

AiResearch Mfg. Co., Torrance, CA (USA)
Advanced electric propulsion system concept for electric vehicles, 5:26083 (DOE/NASA/0081—79/1)

Air Products and Chemicals, Inc., Allentown, PA (USA)
Cryogenic methane separation/catalytic hydrogasification process analysis. First quarter report, October 15, 1978-January 15, 1979, 5:25132 (FE—3044-T7)

Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center
Solar heating and cooling commercialization research program. Final report, 5:25696 (DSE—4218-T1)

Alberta Univ., Edmonton (Canada). Dept. of Chemistry
Classical ionic fluids in the mean spherical approximation, 5:26194 (CONF-800630—1)

Allied-General Nuclear Services, Barnwell, SC (USA)
Conversion of mixed plutonium-uranium oxides, 5:25348 (AGNS—35900-CONF-69)
Measuring process solutions in a reprocessing plant to 0.1%, 5:25431 (AGNS—35900-CONF-72)

Altas Corp., Santa Cruz, CA (USA)
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring insruments: selection, calibration, and installation. Final report, 5:25700 (EPRI-ER—1239(Vol.2))

Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.
Production of aluminum-silicon alloy and ferrosilicon and commercial purity aluminum by the direct reduction process. Fourth interim technical report, Phase B, June 1-August 31, 1979, 5:26090 (CONS—5089-8)

American Management Systems, Inc., Arlington, VA
Appication of interstate compacts to energy-facility siting, 5:25961 (DOE/EV/10274—2)
Feasibility study: PASS computer environment, 5:26760 (DOE/EV/10274—4)
Policy Analysis Screening System (PASS) demonstration: sample queries and terminal instructions, 5:25983 (DOE/EV/10274—3)
Potential of mediation for resolving environmental disputes related to energy facilities, 5:25960 (DOE/EV/10274—1)

Ames Lab., IA (USA)
Alloy evaluation for fossil fuel process plants (liquefaction). Quarterly report, January 1-March 31, 1980, 5:26102 (IS—4742)
Fossil energy quarterly report, January 1-March 31, 1980, 5:25134 (IS—4739)
Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides. Technical progress report, first quarter, year one, 5:25598 (IS—4724)
Review of organic emissions from selected combustion processes, 5:26220 (IS—4727)

Amoco Production Co., Houston, TX (USA)
Sedimentology, petrology, and gas potential of the Brallier Formation: upper Devonian turbidite facies of the Central and Southern Appalachians, 5:25304 (DOE/METC/5201—5)
Analytic Sciences Corp., Reading, MA (USA)
Bedded-salt repository analysis. Final report, 5:25418 (UCRL—15236)
Spatial patterns of radiological dose from wells drilled near nuclear waste repositories, 5:25417 (UCRL—15235)
Applied Decision Analysis, Inc., Menlo Park, CA (USA)
Prototype analysis of EPRI R and D funding. Final report, 5:25975 (EPRI-EA—1366)
Argonne National Lab., IL (USA)
Framework for projecting employment and population changes accompanying energy development, 5:25955 (ANL/AA—14(Vol.1))
Framework for projecting employment and population changes accompanying energy development, 5:25956 (ANL/AA—14(Vol.2))
ILN RJE user's guide for PDP-11/RSX-11M hosts, 5:26743 (ANL/AMD/TM—349)
ILN RJE user's guide for TI990/TX990 hosts, 5:26742 (ANL/AMD/TM—348)
Materials program plan for inertial confinement fusion, 5:26732 (ANL/FPP/TM—126)
Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies, 5:25599 (DOE/ER—0051)
Monitoring stibine and arsine in lead-acid battery charge gas and in ambient air: development and testing of a field kit, 5:25948 (ANL/OEPM—78-4)
Proceedings of the workshop on sputtering caused by plasma (neutral beam) surface interaction, 5:26661 (CONF-790775—)
Radiological and Environmental Research Division. Annual report, 5:26403 (ANL—79-65(Pt.2))
Scientific Affairs Division of NATO Advanced Study Institute: abstracts for nonequilibrium superconductivity, phonons and Kapitza boundaries, 5:26509 (ANL—80-35)
Stress-corrosion cracking of steels in ammonia with consideration given to OTEC design: a survey, 5:25642 (ANL/OTEC-BCM—008)
Toxicities of selected substances to freshwater biota, 5:26436 (ANL/ES—94)
TSOAK-M1: a computer code to determine tritium reaction/adsorption/release parameters from experimental results of air-detritiation tests, 5:26720 (ANL—79-82)
Arizona State Univ., Tempe (USA). School of Engineering
Terrestrial photovoltaic power systems with sunlight concentration, 5:25584 (SAND—80-7008)
Arizona Univ., Tucson (USA). Engineering Experiment Station
Modeling and analysis of electricity demand by time-of-day, 5:26002 (EPRI-EA—1304)
Army Natick Research and Development Command, MA (USA)
The triarylmethane photochromic system for flashblindness protection. Progress report, 5:26408 (AD-A—077412/5)
Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)
MHD high performance demonstration experiment. Quarterly progress report, October 1, 1979-December 31, 1979, 5:26006 (FE—2895-7)
Report on the MHD performance demonstration experiment, October 1, 1978-September 30, 1979, 5:26004 (FE—2895-6)
Aspen Inst. for Humanistic Studies, Boulder, CO (USA)
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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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AC06-76RL01857	UNC Nuclear Industries, Inc., Richland, WA (USA)	
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AC06-77RL01030	Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations	
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AC08-76NV01183	EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group	
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AC08-76NVO1183	EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group	
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AC08-77ET28459	CK GeoEnergy Corp., Las Vegas, NV (USA)	
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AC08-77ET28460	Gruy Federal, Inc., Houston, TX (USA)	
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AC08-79BC10003	CER Corp., Las Vegas, NV (USA)	
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AC08-79NV10039	Nevada Bureau of Mines and Geology, Reno (USA)	
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AC08-80NV10061	Westinghouse Electric Corp., Mercury, NV (USA). Advanced Energy Systems Div.	
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AC09-76SR00001	Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.	
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AC09-78ET35900	Allied-General Nuclear Services, Barnwell, SC (USA)	
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AC090-76SR00001	Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.	
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AC22-79PC10346	Wayne State Univ., Detroit, MI (USA). Coll. of Engineering Energy Center	
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AC32-79AL10563	Republic Geothermal, Inc., Santa Fe Springs, CA (USA)	
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AI01-79ET20305	Boeing Engineering and Construction Co., Seattle, WA (USA)	
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AI08-76DP00539	Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab.	
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AM07-76ID01570	EG and G Idaho, Inc., Idaho Falls (USA)	
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AP01-79ET23124	Ultrasystems, Inc., McLean, VA (USA)	
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AS02-76ER03158	Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering	
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AS02-78ER05002	Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering	
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AS02-78ER14953	Illinois Inst. of Tech., Chicago (USA). Dept. of Chemistry	
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AS03-79ET27023	Hawaii Univ., Honolulu (USA). Hawaii Inst. of Geophysics	
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AT03-76ET51011	General Atomic Co., San Diego, CA (USA)	
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EA-77-A-01-6010-024	National Bureau of Standards, Boulder, CO (USA). Fracture and Deformation Div.	
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EM-78-S-01-5235	Texas Univ., Austin (USA). Center for Energy Studies	
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EN-77-C-02-4057	General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.	
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ET-78-S-01-3405	Pennsylvania State Univ., University Park (USA). Dept. of Nuclear Engineering	
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CONF-791112-	(Symposium on the scientific basis for nuclear waste management, Boston, MA, USA, 26 Nov 1979,-29 Nov 1979/REPLACES CONF-791173)	
66	5:25363	Dep. NTIS, PC A02/MF A01
CONF-791134-	(16. international thermal conductivity conference, Chicago, IL, USA, 7-9 Nov 1979)	
13	5:26117	NTIS, PC A02/MF A01
CONF-791160-	(2. international symposium on coal-oil mixture combustion, Danvers, MA, USA, 27-29 Nov 1979)	
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CONF-791184-	(9. annual hydrometallurgical meeting, Toronto, Canada, 11-13 Nov 1979)	
1	5:25351	NTIS, PC A02/MF A01
CONF-791188-	(4. international symposium on computer assisted cartography, Reston, VA, USA, 4-8 Nov 1979)	
1	5:25282	NTIS, PC A02/MF A01
2	5:26395	NTIS, PC A02/MF A01
CONF-791232-	(Thermal energy storage review meeting, Tysons Corner, VA, USA, 3 Dec 1979,-4 Dec 1979/REPLACES CONF-791242)	
	5:25805	NTIS, PC A99/MF A01
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CONF-791234-	(Environmental decontamination workshop, Oak Ridge, TN, USA, 4-5 Dec 1979)	
2	5:25428	*See* LA-UR-80-926
CONF-800102-	(International conference on geotechnical and environmental aspects of geopressure energy, Sea Island, GA, USA, 13-20 Jan 1980)	
4	5:25831	*See* UCRL-83122(Rev.1)
CONF-800129-	(Energy from biomass and wastes 4 symposium, Lake Buena Vista, FL, USA, 21-25 Jan 1980)	
6	5:25462	Chicago, IL; Institute of Gas Technology (1980).
CONF-800213-	(Band structure and nuclear dynamics conference, New Orleans, LA, USA, 28 Feb-1 Mar 1980)	
9	5:26611	*See* BNL-27501
CONF-800232-	(International conference on extreme states in nuclear systems, Dresden, German Democratic Republic, 4-8 Feb 1980)	
2	5:26601	*See* LBL-10624
CONF-800236-	(Conference on computational astrophysics, Hampton, VA, USA, Feb 1980)	
1	5:26473	*See* UCRL-84410
CONF-800237-	(International symposium on coastal upwelling, Los Angeles, CA, USA, 4-8 Feb 1980)	
1	5:26324	*See* BNL-27636
CONF-800238-	(19. internationale universitatswochen fur kernphysik, Schladming, Austria, 20-29 Feb 1980)	
1	5:26541	*See* DOE/ER/03069-776
CONF-800302-	(25. international gas turbine conference, New Orleans, LA, USA, 9-13 Mar 1980)	
6	5:26071	Chicago, IL; Institute of Gas Technology (1980).
CONF-800307-	(Fiber optic in the nuclear environment symposium, Adelphi, MD, USA, 25 Mar 1980,-27 Mar 1980/REPLACES CONF-800322)	
4	5:26139	*See* SAND-80-0831C
CONF-800309-	(International workshop on the energy/climate interactions, Munster, F.R. Germany, 3-7 Mar 1980)	
6	5:25959	NTIS, PC A02/MF A01
CONF-800315-	(2. symposium of the European Safeguards Research and Development Association, Edinburgh, UK, 26 Mar 1980)	
15	5:25431	*See* AGNS-35900-CONF-72
19	5:25433	*See* BNL-27664
20	5:25432	*See* BNL-27660
CONF-800327-	(2. joint conference on applications of air pollution meteorology, New Orleans, LA, USA, 24-27 Mar 1980)	
6	5:26295	*See* LA-UR-80-805
7	5:26294	*See* LA-UR-80-792
8	5:26293	*See* LA-UR-80-791
12	5:26296	*See* BNL-27804
CONF-800355-	(State energy audit impact '80 conference, St Louis, MO, USA, 31 Mar-2 Apr 1980)	
1	5:25551	*See* SERI/TP-451-597
CONF-800360-	(International conference on thermal stresses in materials and structures in severe thermal environments, Blacksburg, VA, USA, 19-20 Mar 1980)	
1	5:25897	*See* HEDL-SA-2066-FP
CONF-800366-	(Specialists' meeting on LMFBR instrumentation and control, Tokyo, Japan, 31 Mar-4 Apr 1980)	
1	5:25909	*See* HEDL-SA-2023
2	5:25908	*See* HEDL-SA-2022
CONF-800368-	(2. international conference on phase equilibria and fluid properties in the chemical industry, Berlin, F.R. Germany, 17-21 Mar 1980)	

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1	5:26200	*See* LBL-10767
CONF-800369-	(International symposium on atomic, molecular, and solid-state theory, Flagler Beach, FL, USA, 10-14 Mar 1980)	
1	5:26193	*See* BNL-27677
CONF-800370-	(Supernova type I workshop, Austin, TX, USA, 17-19 Mar 1980)	
1	5:26467	*See* UCRL-84354
CONF-800371-	(5. international technical conference of slurry transportation, Lake Tahoe, NV, USA, 26-28 Mar 1980)	
1	5:25138	NTIS, PC A02/MF A01
CONF-800372-	(2. annual Park City environmental health conference, Park City, UT, USA, 27-29 Mar 1980)	
1	5:26446	*See* BNL-27681
CONF-800373-	(Plant engineering and maintenance conference, McCormick Place, Chicago, IL, USA, 24-27 Mar 1980)	
1	5:25743	*See* SERI/TP-731-626
CONF-800374-	(15. Rencontre de Moriond, Les Arcs, France, 9-12 Mar 1980)	
1	5:26576	*See* SLAC-PUB-2491
2	5:26515	*See* SLAC-PUB-2492
CONF-800401-	(2. international conference of liquid metal technology for energy systems, Richland, WA, USA, 20-24 Apr 1980)	
11	5:26735	*See* HEDL-SA-1918-FP
CONF-800402-	(International symposium on the properties and applications of metal hydrides, Colorado Springs, CO, USA, 7-11 Apr 1980)	
12	5:26192	*See* BNL-27523
CONF-800403-	(ANS thermal reactor safety meeting, Knoxville, TN, USA, 8-11 Apr 1980)	
41	5:26455	NTIS, PC A02/MF A01
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3	5:25458	*See* LBL-10655
4	5:26221	*See* LBL-10679
CONF-800420-	(2. international ocean disposal symposium, Woods Hole, MA, USA, 15-18 Apr 1980)	
4	5:25410	*See* SAND-79-2328C
CONF-800430-	(Conference on physics of fiber optics, Chicago, IL, USA, 28-30 Apr 1980)	
2	5:26123	*See* SAND-79-2350C
CONF-800439-	(International conference on metallurgical coatings, San Diego, CA, USA, 21-25 Apr 1980)	
1	5:26144	*See* SAND-79-2167C
5	5:25791	*See* RFP-3021
6	5:25790	*See* LBL-10293
CONF-800453-	(International optical computing conference, Washington, DC, USA, 7-11 Apr 1980)	
1	5:26273	*See* SAND-80-0026
CONF-800455-	(4. international conference on plasma surface interactions in controlled fusion devices, Garmisch, F.R. Germany, 21-25 Apr 1980)	
10	5:26675	*See* GA-A-15821
CONF-800460-	(82. annual American Ceramic Society meeting, Chicago, IL, USA, 27-30 Apr 1980)	
4	5:25372	*See* DP-MS-79-91
CONF-800470-	(DOE decommissioning criteria workshop, Kansas City, MO, USA, 15-16 Apr 1980)	
1	5:25444	*See* LA-UR-80-1115
CONF-800471-	(Seminar on theory and applications of Monte Carlo methods, Oak Ridge, TN, USA, Apr 1980)	
3	5:25904	*See* LA-UR-80-1158
CONF-800476-	(13. Jerusalem symposium on carcinogenesis: fundamental mechanisms and environmental effects, Jerusalem, Israel, 28 Apr-2 May 1980)	
1	5:26399	*See* BNL-27643
CONF-800477-	(American Nuclear Society topical conference, Mayagues, Puerto Rico, 30 Apr-4 May 1980)	
1	5:26177	*See* UCRL-80286(Rev.1)
CONF-800480-	(ASCOT program planning meeting, Gettysburg, PA, USA, 15-18 Apr 1980)	
2	5:26458	*See* UCRL-84091
CONF-800529-	(American Society for Information Service mid-year meeting, Pittsburgh, PA, USA, 15 May 1980)	
3	5:25996	*See* LBL-10248
CONF-800535-	(ASME Idaho section symposium, Idaho Falls, ID, USA, 29 May 1980)	
3	5:25364	NTIS, PC A02/MF A01
CONF-800542-	(Concrete decontamination workshop, Seattle, WA, USA, 28-29 May 1980)	
1	5:25360	*See* UNI-SA-74
CONF-800544-	(Electrochemical Society meeting, St Louis, MO, USA, 11-16 May 1980)	
1	5:25449	NTIS, PC A02/MF A01
CONF-800551-	(Symposium on neutron cross sections from 10 - 50 MeV, Upton, NY, USA, 12-14 May 1980)	
9	5:26250	*See* LA-UR-80-1360
CONF-800552-	(Topical conference on basic optical properties of materials, Gaithersburg, MD, USA, 5-7 May 1980)	
1	5:26170	*See* UCRL-84399
CONF-800553-	(4. workshop on catalytic combustion, Cincinnati, OH, USA, 14-15 May 1980)	
1	5:26222	*See* LBL-10842
CONF-800555-	(International conference on lasers, Shanghai, China, 3-15 May 1980)	
1	5:26723	*See* SAND-80-0696C
CONF-800556-	(Annual spring meeting of the American Geophysical Union, Toronto, Ontario, Canada, 22-24 May 1980)	
1	5:25385	*See* DP-MS-80-7
CONF-800601-	(13. Rochester international conference on environmental toxicity--measurement of risks, Rochester, NY, USA, 2-4 Jun 1980)	
1	5:26447	*See* BNL-27912
CONF-800602-	(Symposium on instrumentation and control for fossil energy processes, Virginia Beach, VA, USA, 9-11 Jun 1980)	
3	5:26334	NTIS, PC A02/MF A01
4	5:26297	NTIS, PC A02/MF A01
CONF-800604-	(American section of the International Solar Energy Society conference, Phoenix, AZ, USA, 2-6 Jun 1980)	
10	5:25757	*See* SERI/TP-632-635
11	5:25702	*See* LA-UR-80-1076
12	5:25704	*See* LA-UR-80-1087
13	5:25703	*See* LA-UR-80-1080
18	5:25742	*See* SERI/TP-631-655
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27	5:25563	*See* COO-4094-88
CONF-800607-	(American Nuclear Society annual meeting, Las Vegas, NV, USA, 8-13 Jun 1980)	
47	5:26630	NTIS, PC A02/MF A01
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53	5:25374	*See* LA-UR-80-1408
54	5:25420	*See* UCRL-83728
56	5:26733	NTIS, PC A02/MF A01
CONF-800609-	(10. international symposium on effects of radiation on materials, Savannah, GA, USA, 3-5 Jun 1980)	
2	5:26137	NTIS, PC A02/MF A01
CONF-800610-	(American Institute of Chemical Engineering conference, Philadelphia, PA, USA, 8-12 Jun 1980)	
6	5:25325	*See* UCRL-84142
CONF-800611-	(International symposium on the management of alpha-contaminated wastes, Vienna, Austria, 2-6 Jun 1980)	
3	5:26182	*See* LA-UR-80-1274
4	5:25366	*See* LA-UR-80-1289
6	5:25367	*See* LA-UR-807145
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6	5:25450	*See* GA-A-15777
CONF-800617-	(7. international conference on MHD electrical power generation, Cambridge, MA, USA, 16-20 Jun 1980)	
4	5:26007	NTIS, PC A02/MF A01
5	5:26008	NTIS, PC A02/MF A01
CONF-800624-	(Power electronics specialists conference, Atlanta, GA, USA, 17-19 Jun 1980)	
1	5:26249	*See* BNL-27495
CONF-800626-	(6. international conference on vacuum ultraviolet radiation physics, Charlottesville, VA, USA, 2-6 Jun 1980)	
2	5:26492	NTIS, PC A02/MF A01
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1	5:26181	*See* UCRL-84351
CONF-800630-	(5. international symposium on solute-solvent interactions, Florence, Italy, 2-6 Jun 1980)	
1	5:26194	NTIS, PC A03/MF A01
CONF-800631-	(8. international cryogenic engineering conference, Genoa, Italy, 3-6 Jun 1980)	
1	5:26510	*See* LBL-10923
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5	5:26728	*See* UCRL-83916
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1	5:26050	*See* LBL-10163
CONF-800636-	(Adhesives in industry conference, El Segundo, CA, USA, 24-25 Jun 1980)	
1	5:26149	*See* BDX-613-2436
CONF-800637-	(Plasma symposium, San Francisco, CA, USA, 19-20 Jun 1980)	
1	5:26153	*See* SAND-80-1228C
CONF-800709-	(Seminar on high-energy nuclear interactions and properties of dense nuclear matter, Hakone, Japan, 7-11 Jul 1980)	
1	5:26614	*See* LA-UR-80-1280
CONF-800713-	(7. international pyrotechnics seminar, Vail, CO, USA, 14-18 Jul 1980)	
10	5:26136	*See* SAND-80-1170C
11	5:26274	*See* SAND-80-0203C
12	5:26284	*See* SAND-80-0204C
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1	5:26506	*See* K/ET-5011
CONF-800716-	(6. underground coal conversion symposium, Afton, OK, USA, 13-17 Jul 1980)	
1	5:25175	*See* UCRL-84086
2	5:25171	*See* MLM-2731(OP)
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1	5:26460	*See* LA-UR-80-204
CONF-800719-	(International symposium of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA, USA, 28 Jul-1 Aug 1980)	
1	5:26260	*See* UCRL-84109
2	5:26272	*See* SAND-75-0287C
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1	5:26066	NTIS, PC A02/MF A01
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1	5:25883	*See* LA-UR-80-125
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1	5:26230	*See* SAND-79-2354C
5	5:26231	*See* SAND-80-0062C
8	5:26722	NTIS, PC A02/MF A01
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1	5:26271	*See* LBL-10682
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1	5:25353	*See* DP-MS-80-38
2	5:25373	*See* DP-MS-80-2
5	5:25591	*See* LBL-10800
7	5:25348	*See* AGNS-35900-CONF-69
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1	5:26238	*See* UCRL-83322
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1	5:25798	*See* SERI/TP-333-591
6	5:25793	*See* SAND-79-2044C
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